5.4.7 Hurricane

This section provides a profile and vulnerability assessment for the hurricane hazards.

Hazard Profile

Hazard profile information is provided in this section, including information on description, extent, location, previous occurrences and losses and the probability of future occurrences within Suffolk County.

Description

Hurricanes and tropical storms are the major types of storm events generally impact the New York State coastline and adjacent inland areas. These storms typically impact the State from June to November, which is the official eastern U.S. hurricane season. Between late July and early October is the period of time that a hurricane or tropical storm is most likely to impact New York State (NYS DHSES, 2011).

Extra-tropical storms (Nor'Easters) typically occur during winter months. These storms are usually less intense, but can have localized wind velocities that generally reach hurricane strength (NYS DHSES, 2011). Nor'Easters are discussed in Section 5.4.9 of this HMP.

A tropical cyclone is a rotating, organized system of clouds and thunderstorms that originates over tropical or sub-tropical waters and has a closed low-level circulation. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (National Oceanic and Atmospheric Administration [NOAA] 2013). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development. The average wind speeds for tropical storms and hurricanes are listed below:

- A tropical depression has a maximum sustained wind speeds of 38 miles per hour (mph) or less
- A tropical storm has maximum sustained wind speeds of 39 to 73 mph
- A hurricanes has maximum sustained wind speeds of 74 mph or higher. In the western North Pacific, hurricanes are called typhoons; similar storms in the Indian Ocean and South Pacific Ocean are called cyclones.
- A major hurricane has maximum sustained wind speeds of 111 mph or higher (NOAA 2013).

Over a 2-year period, the U.S. coastline is struck by an average of three hurricanes, one of which is classified as a major hurricane. Hurricanes, tropical storms and tropical depressions pose a threat to life and property. These storms bring heavy rain, storm surge and flooding (NOAA 2013).

Hurricanes and tropical storms often occur at the same time. Because of this, officials assign short, distinctive names to the storms to avoid confusion among weather stations, coastal bases, and ships at sea. Since 1953, Atlantic tropical storms have been named from lists originated by the National Hurricane Center. Currently, they are maintained and updated by the World Meteorological Organization. The list of names in the table below are used in rotation and recycled every 6 years. For example, the 2013 list will be used again in 2019. The only time there is a change in the list is if the named storm was so costly or deadly that the future use of it would be inappropriate. If that occurs, the World Meteorological Organization committee will select a new name to replace the one removed from the list. If all the names in a season's list have been used, later storms are named for Greek letters, in alphabetical order. A storm is given a name once its winds reach a speed of 40 mph. In addition to the Atlantic list of names, there are

ten other lists corresponding to other storm-prone regions of the world (NOAA 2013). Table 5.4.7-1 lists the tropical cyclone names for 2013 through 2018.

Table 5.4.7-1. Tropical Cyclone Names for the Atlantic

2014	2015	2016	2017	2018
Arthur	Ana	Alex	Arlene	Alberto
Bertha	Bill	Bonnie	Bret	Beryl
Cristobal	Claudette	Colin	Cindy	Chris
Dolly	Danny	Danielle	Don	Debby
Edouard	Erika	Earl	Emily	Ernesto
Fay	Fred	Fiona	Franklin	Florence
Gonzalo	Grace	Gaston	Gert	Gordon
Hanna	Henri	Hermine	Harvey	Helene
Isaias	Ida	Ian	Irma	Isaac
Josephine	Joaquin	Julia	Jose	Joyce
Kyle	Kate	Karl	Katia	Kirk
Laura	Larry	Lisa	Lee	Leslie
Marco	Mindy	Matthew	Maria	Michael
Nana	Nicholas	Nicole	Nate	Nadine
Omar	Odette	Otto	Ophelia	Oscar
Paulette	Peter	Paula	Philippe	Patty
Rene	Rose	Richard	Rina	Rafael
Sally	Sam	Shary	Sean	Sara
Teddy	Teresa	Tobias	Tammy	Tony
Vicky	Victor	Virginie	Vince	Valerie
Wilfred	Wanda	Walter	Whitney	William

Source: NOAA 2013

Tropical Storms

A tropical storm system is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain (winds are at a lower speed than hurricane-force winds, thus gaining its status as tropical storm versus hurricane). Tropical storms strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. They are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA 1999).

The term "tropical" refers both to the geographical origin of these systems, which usually form in tropical regions of the globe, and to their formation in maritime tropical air masses. The term "cyclone" refers to such storms' cyclonic nature, with counterclockwise wind flow in the Northern Hemisphere, and clockwise wind flow in the Southern Hemisphere. The opposite direction of the wind flow is a result of the Coriolis force (National Weather Service [NWS] 2010).

Tropical storms and tropical depressions, while generally less dangerous than hurricanes, can be deadly. The winds of tropical depressions/storms are usually not the greatest threat; rather, the rains, flooding, and

severe weather associated with the tropical storms are what customarily cause more significant problems. Serious power outages can also be associated with these types of events (New York City Office of Emergency Management [NYCOEM] Date Unknown; NOAA 1999).

Hurricanes

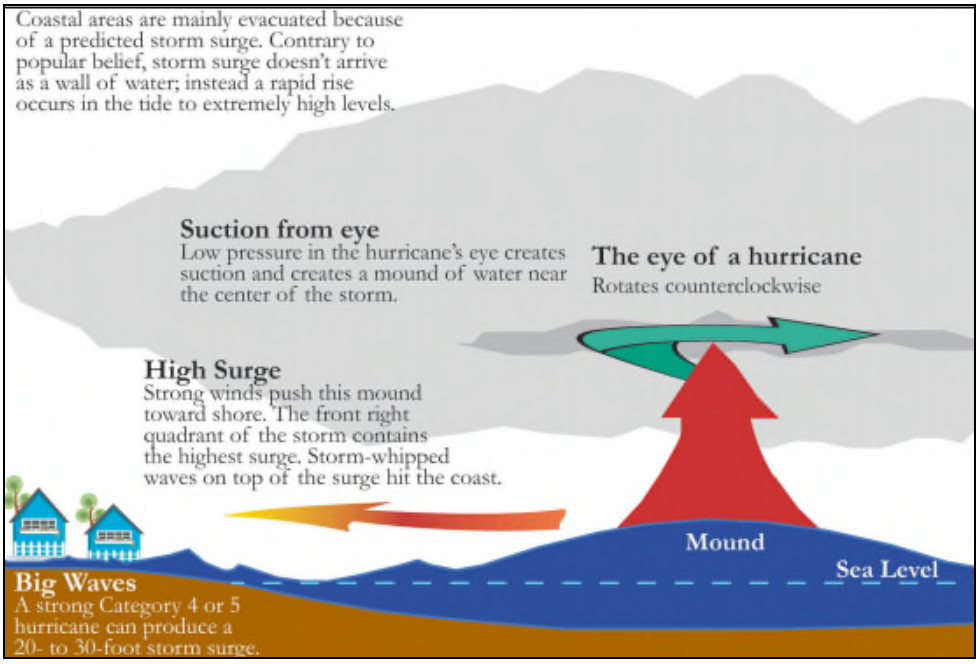
A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles an hour. Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic coast of the United States and impact the eastern seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England before moving offshore and heading east. The Atlantic hurricane season runs from June 1st through November 30th, with the peak of the season from mid-August to late October.

Storm Surge

Storm surges inundate coastal floodplains by dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase in tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and inside bays.

Based on an area's topography, a storm surge may inundate only a small area (along sections of the northeast or southeast coasts) or storm surge may inundate coastal lands for a mile or more inland from the shoreline. Figure 5.4.7-1 depicts storm surge.

Figure 5.4.7-1. Storm Surge



Source: FEMA 2010

Warning Time

The National Weather Service (NWS) issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds (24 hours in the western north Pacific). The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours (24 hours for the western north Pacific) in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013).

Extent

The extent of a hurricane is categorized by the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1 to 5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NHC, 2013). Table 5.4.7-2 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes land fall.

Table 5.4.7-2. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Expected Damage
1	74-95 mph	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.

Category	Wind Speed (mph)	Expected Damage
4 (major)	130-156 mph	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

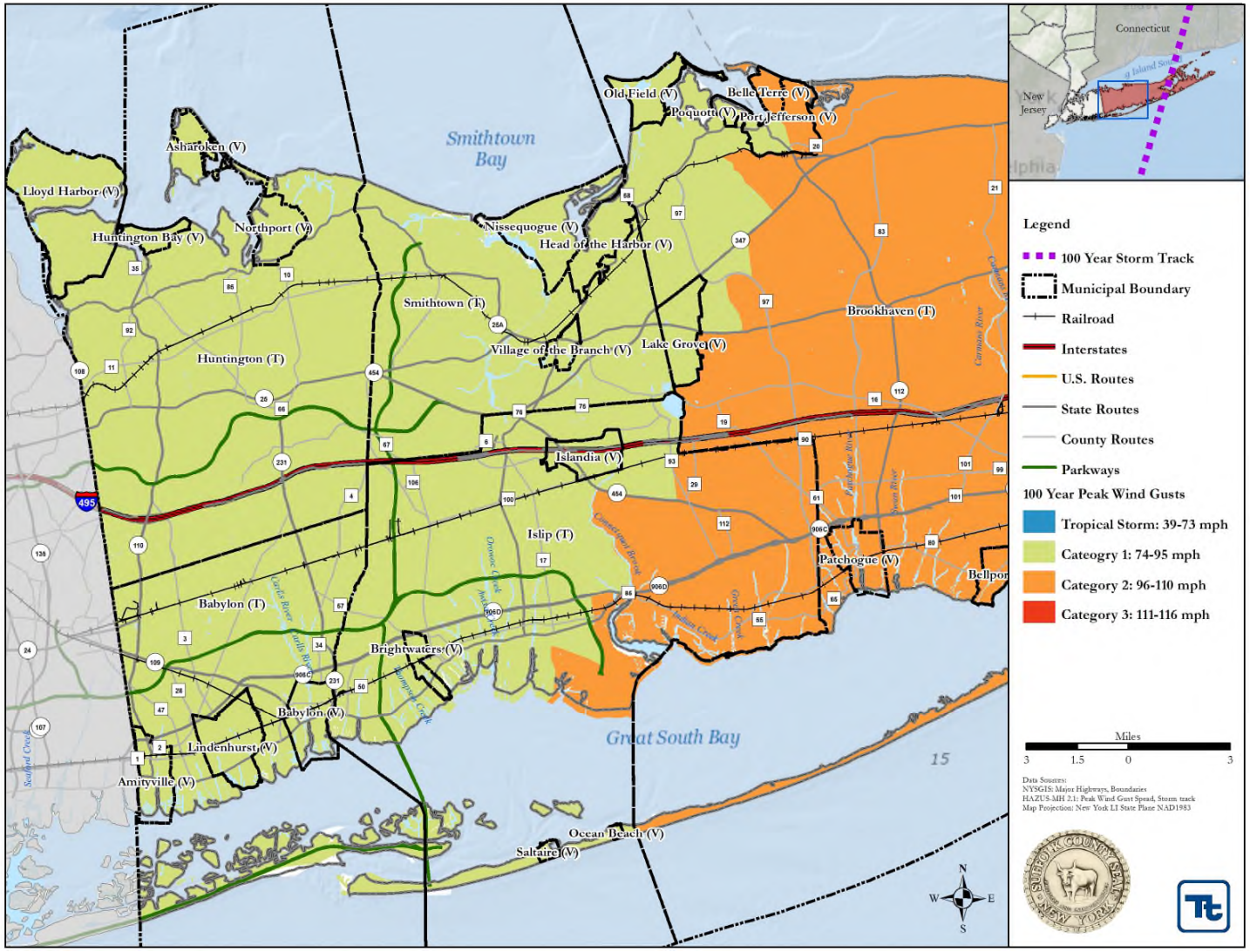
Source: NHC, 2013
mph Miles per hour
> Greater than

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event (equal to the inverse of the annual frequency of exceedance). For example, a flood that has a 1-percent chance of being equaled or exceeded in any given year is also referred to as the base flood and has a MRP of 100. This is known as a 100-year flood. The term "100-year flood" can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a one-percent chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period of time or less than one time in 100 years (Dinicola, 2009).

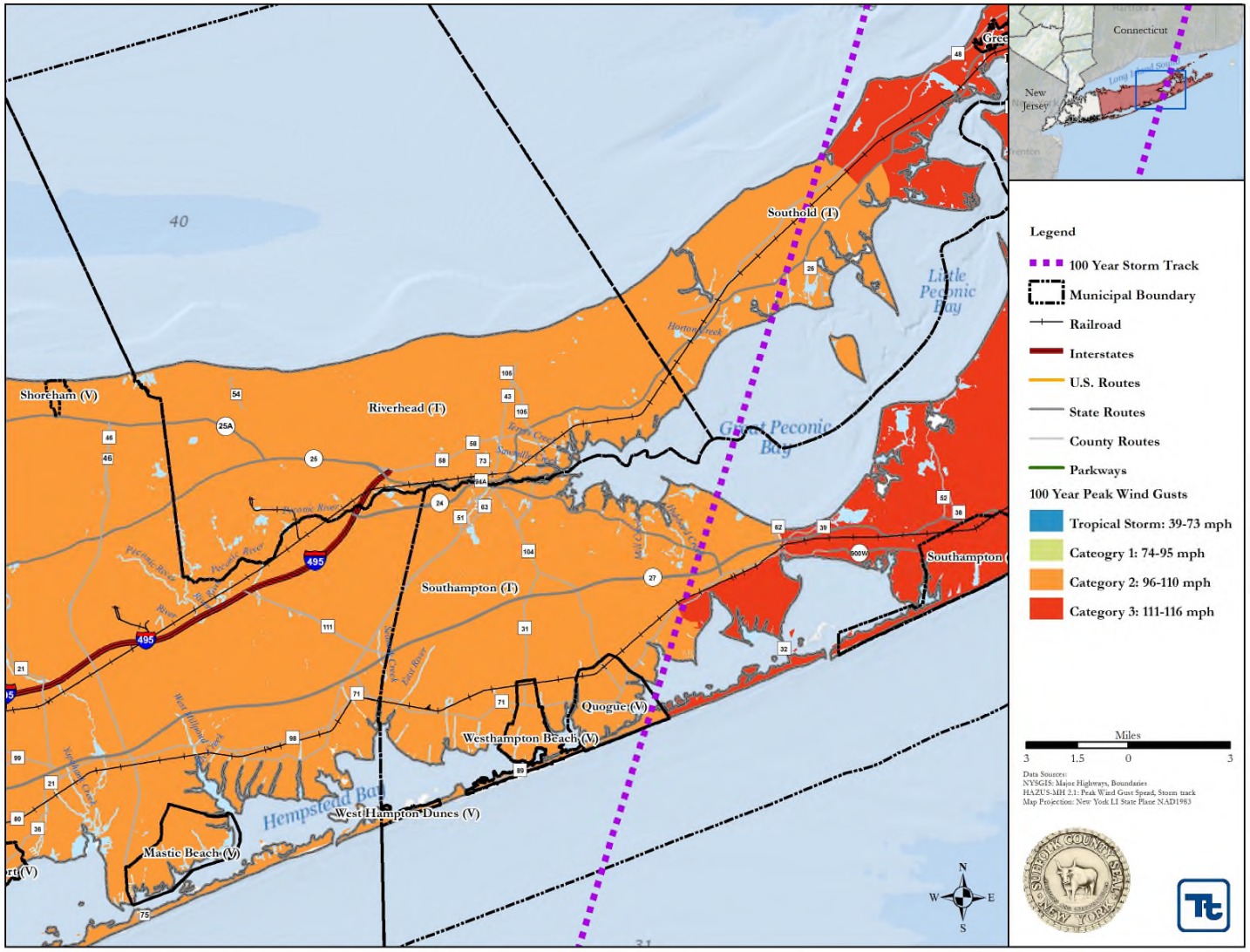
Figure 5.4.7-2 through Figure 5.4.7-7 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP HAZUS-MH model runs. The estimated hurricane track for the 100- and 500-year event is also shown. For the 100-year MRP event, the maximum 3-second wind speeds range from 111 to 116 miles per hour (mph), characteristic of a Category 3 hurricane. For the 500-year MRP event, the maximum 3-second gust wind speeds for the county range from 130 to 153 mph, characteristic of a Category 4 hurricane. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment later in this section.

Figure 5.4.7-2. Wind Speeds and Storm Track for the 100-Year Mean Return Period Event in Suffolk County-West



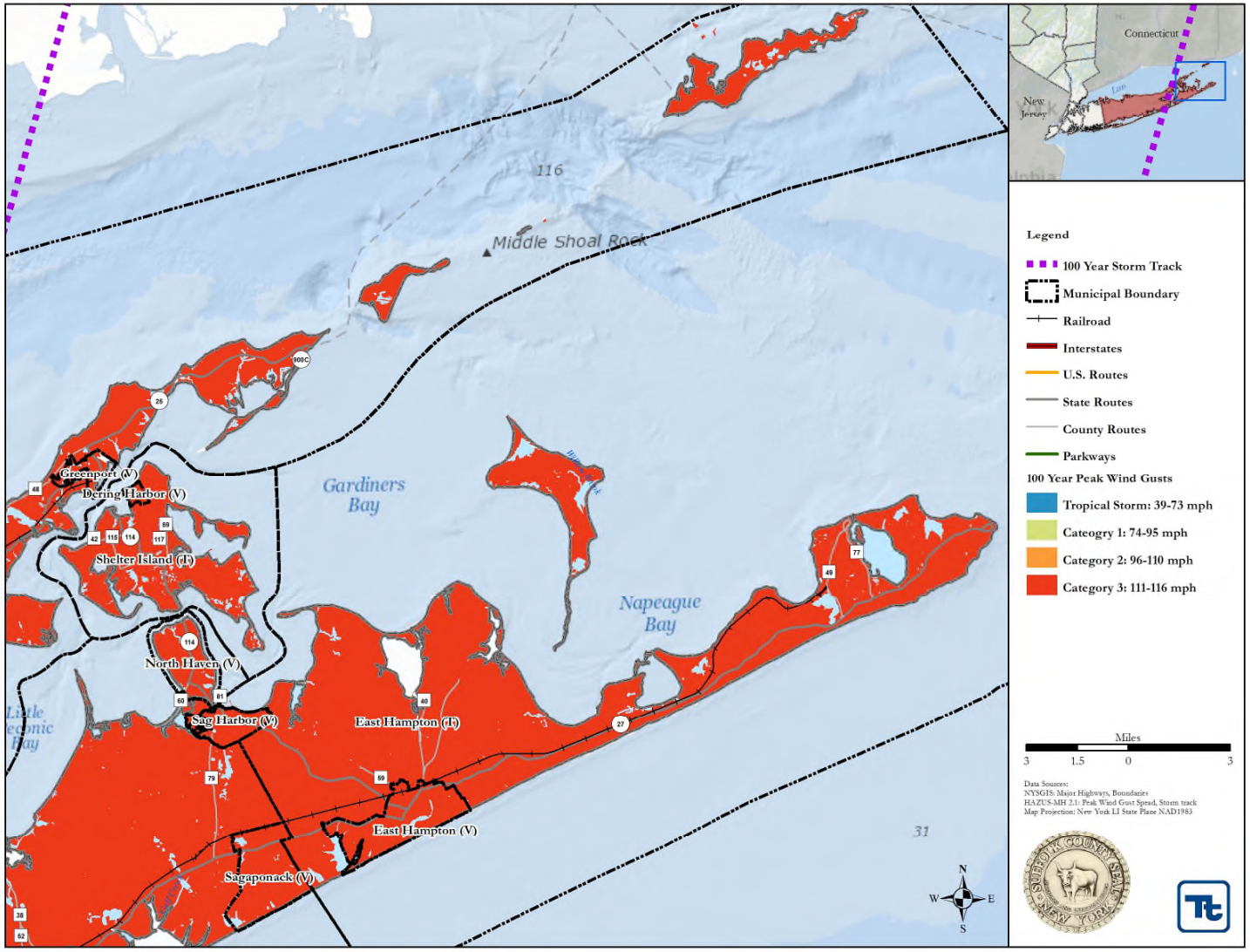
Source: HAZUS-MH 2.1
Note: For the 100-year MRP event, the maximum 3-second wind speeds range from 111 to 116 miles per hour (mph), characteristic of a Category 3 hurricane.

Figure 5.4.7-3. Wind Speeds and Storm Track for the 100-Year Mean Return Period Event in Suffolk County - Central



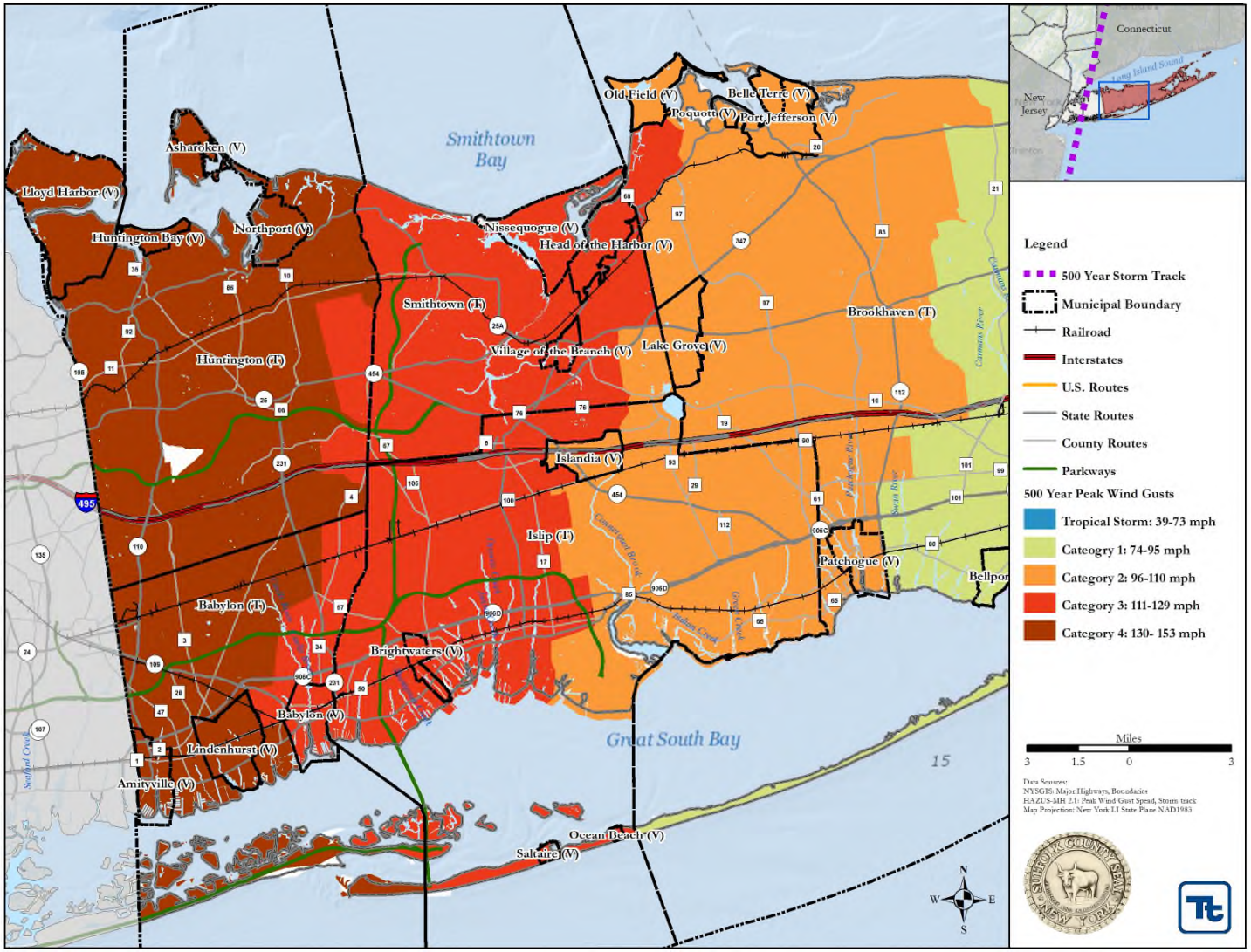
Source: *HAZUS-MH 2.1*
Note: *For the 100-year MRP event, the maximum 3-second gust wind speeds range from 111 to 116 miles per hour, characteristic of a Category 3 hurricane.*

Figure 5.4.7-4. Wind Speeds and Storm Track for the 100-Year Mean Return Period Event in Suffolk County - East



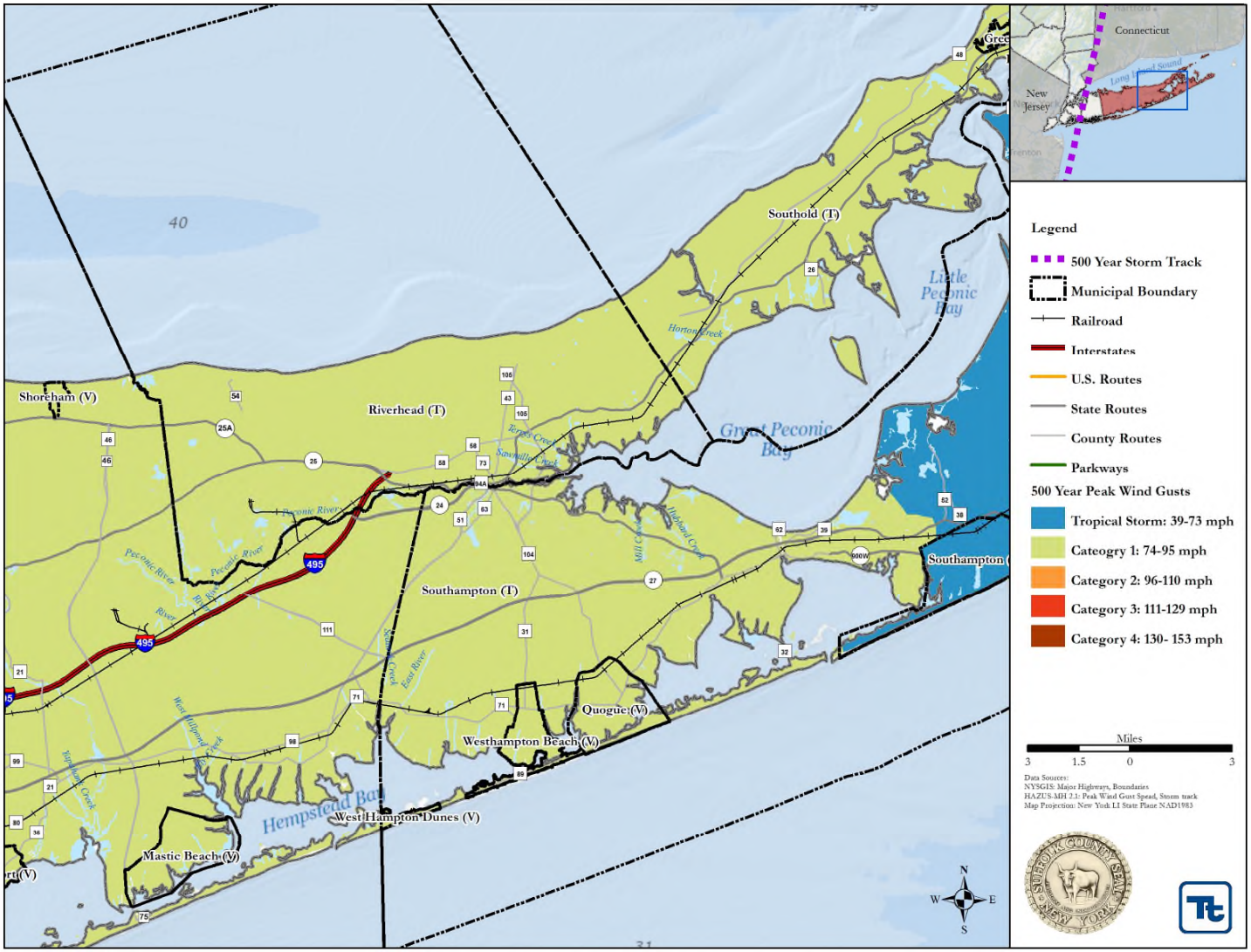
Source: *HAZUS-MH 2.1*
Note: *For the 100-year MRP event, the maximum 3-second gust wind speeds range from 111 to 116 miles per hour, characteristic of a Category 3 hurricane.*

Figure 5.4.7-5. Wind Speeds and Storm Track for the 500-Year Mean Return Period Event in Suffolk County - West



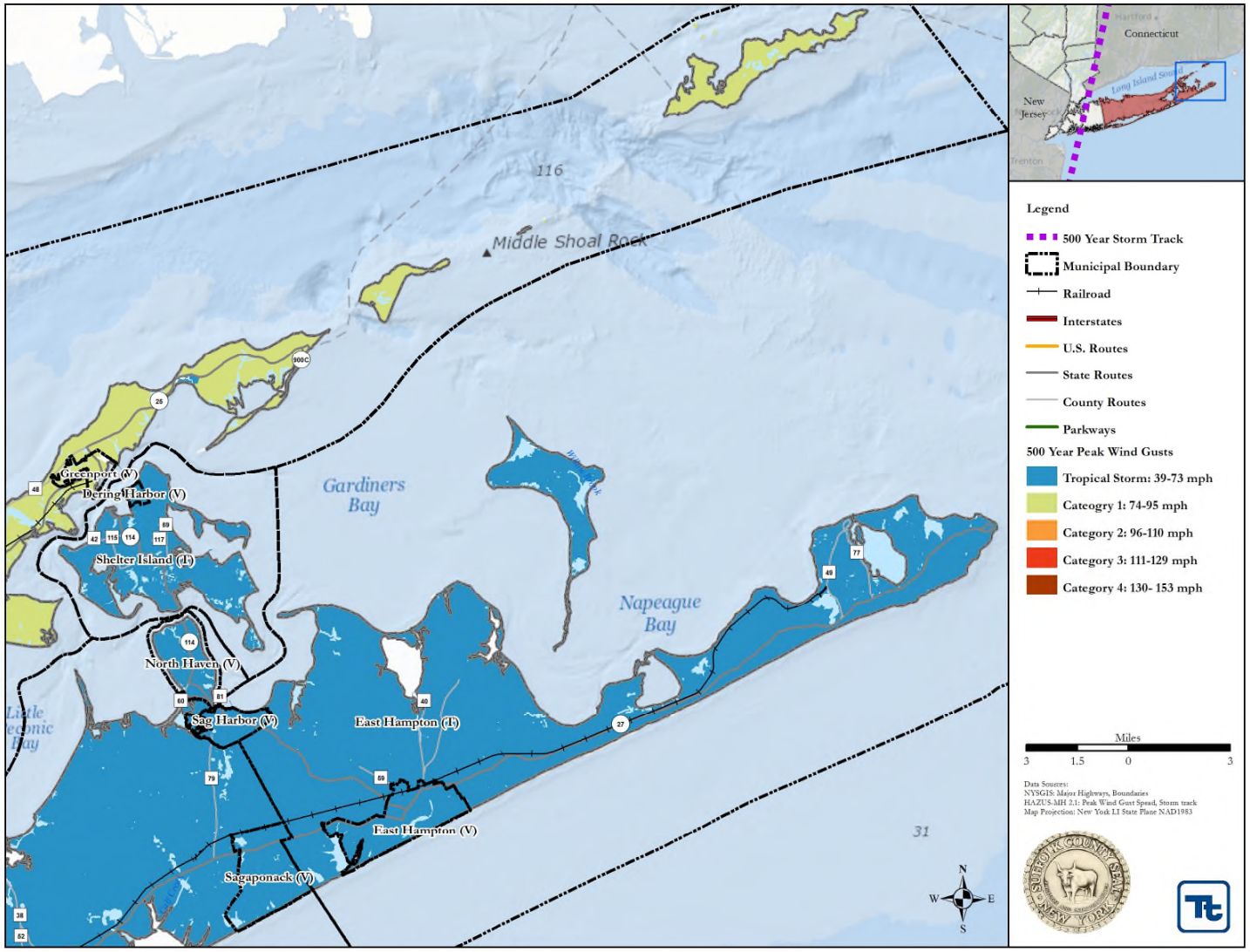
Source: *HAZUS-MH 2.1*
Note: *For the 500-year MRP event, the maximum 3-second gust wind speeds range from 130 to 153 miles per hour, characteristic of a Category 4 hurricane.*

Figure 5.4.7-6. Wind Speeds and Storm Track for the 500-Year Mean Return Period Event in Suffolk County - Central



Source: *HAZUS-MH 2.1*
Note: *For the 500-year MRP event, the maximum 3-second gust wind speeds range from 130 to 153 miles per hour, characteristic of a Category 4 hurricane.*

Figure 5.4.7-7. Wind Speeds and Storm Track for the 500-Year Mean Return Period Event in Suffolk County - East

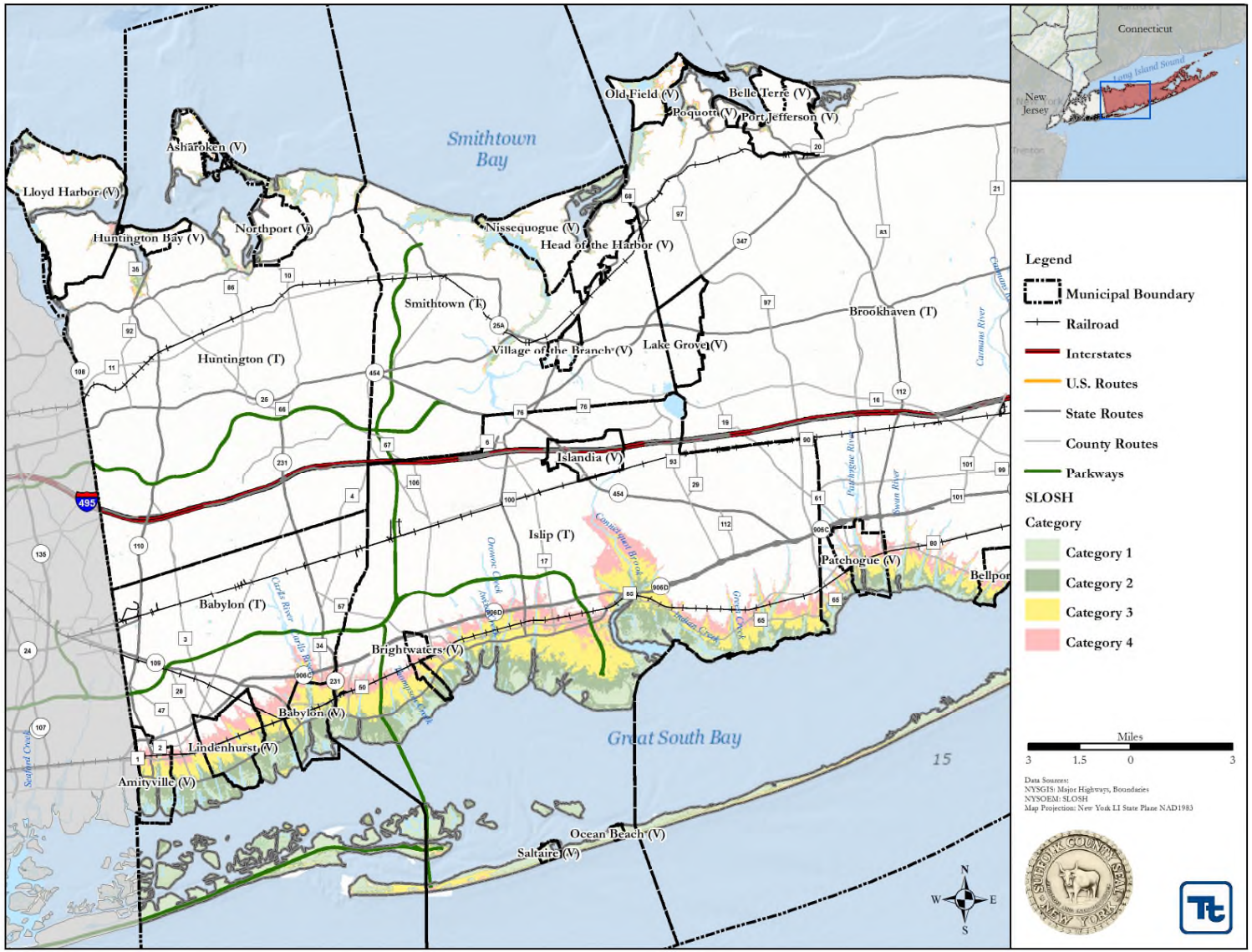


Source: *HAZUS-MH 2.1*
Note: *For the 500-year MRP event, the maximum 3-second gust wind speeds range from 130 to 153 miles per hour, characteristic of a Category 4 hurricane*

The New York State Office of Emergency Management (NYSOEM) utilizes a computer-based model that hypothetically generates the effects of storm surge, as well as assists with planning efforts for coastal storms known as SLOSH (Sea, Lake, and Overland Surges from Hurricanes). This model computes storm surges based on storm movement in different directions and strengths. SLOSH models analyze storms moving northeast, northwest, and changing in strength from Category 1 to Category 4 (NYS DHSES 2013).

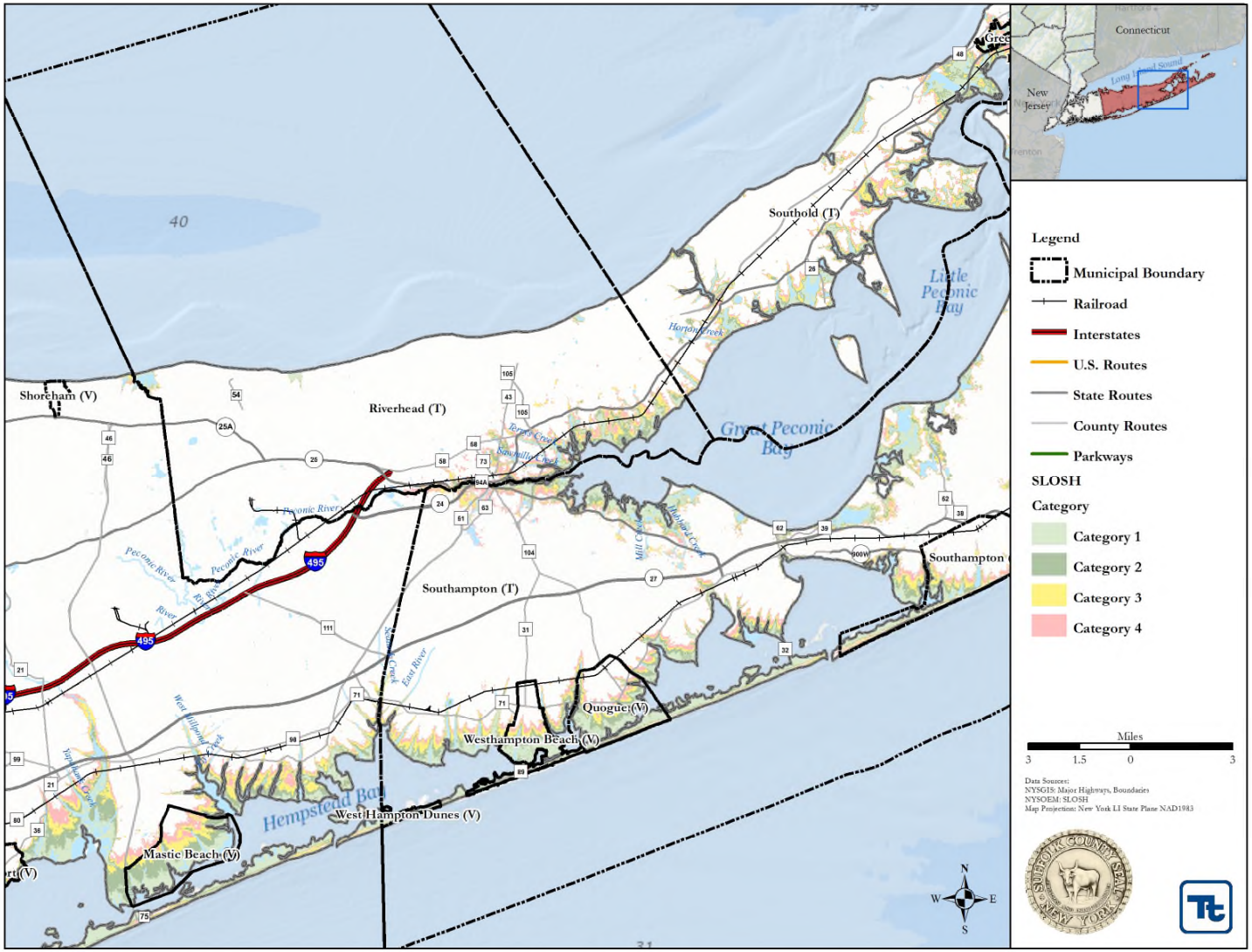
SLOSH calculations are based on storm surges reaching above average tides and strong potential winds for each category storm. The error of this model ranges between plus or minus three feet. SLOSH models can also compute inundation levels for specific locations as if a hurricane hit head-on. For New York State, data generated through SLOSH indicates that the five boroughs of New York City, Nassau, and Suffolk Counties were the primary areas affected; however, areas north of Rockland and Westchester Counties have not been mapped for SLOSH surge zones (NYS DHSES 2013). Figure 5.4.7-8 through Figure 5.4.7-10 illustrate the SLOSH maps for Suffolk County.

Figure 5.4.7-8. Sea Lake Overland Surge from Hurricanes (SLOSH Model) - West



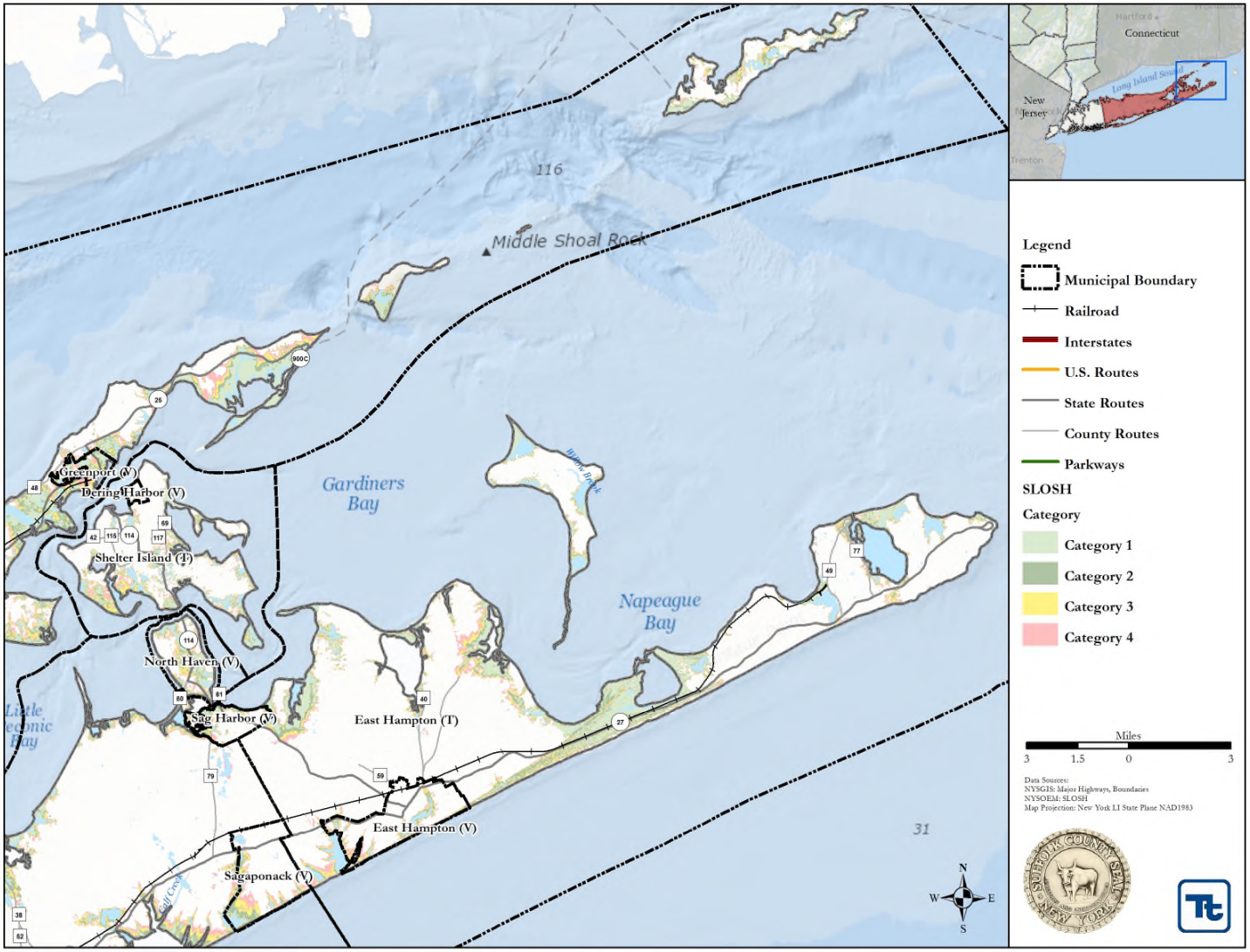
Source: NYSOEM

Figure 5.4.7-9. Sea Lake Overland Surge from Hurricanes (SLOSH Model) - Central



Source: NYSOEM

Figure 5.4.7-10. Sea Lake Overland Surge from Hurricanes (SLOSH Model) - East



Source: NYSOEM

According to computer projections based on SLOSH, large areas of coastal Long Island could be inundated by a storm surge from a major hurricane striking the island at high tide. The southern shore of Suffolk County is most at risk of inundation during a coastal storm, particularly in Babylon, Islip, Patchogue and Fire Island. Fire Island and its summer communities would be overrun by waves in the event of a major hurricane and direct land fall. The surging waters would cut off the eastern end of the South Fork at Napeague, making an island out of Montauk, and would swamp much of the North Fork. Ocean surf would cause major erosion (Rather, 2005).

According to research by Scott Mandia, Professor of Physical Sciences at SUNY Suffolk, the following observations were made regarding the anticipated effects of a storm surge on Long Island.

Category 1 hurricanes inundate just about all of the immediate south shore of the Island, including the north side of Great South Bay locations and both sides of the north and south forks. Montauk Highway (Rt. 27A) is completely covered by flood waters during a Category 3 hurricane. Therefore, this road would be considered impassable during the storm.

A category 4 hurricane inundates the majority of the Villages of: Amityville, Lindenhurst, Babylon, West Islip, East Islip, Bayshore, Gilgo Beach, Cedar Beach, Great South Beach, Fair Harbor, Cherry Grove, Cupsogue, Westhampton Beach, Watermill Beach, Wainscott Beach, Plum Island, Gardiner's Island, Orient, Shelter Island (except for a few high points), Greenport, North Haven, Amagansett Beach, Napeague Beach, Montauk, Woodmere, Valley Stream, Lynbrook, Long Beach, Atlantic Beach, Freeport, Merrick, Wantagh, Lido Beach, Jones Beach, and Tobay Beach (Mandia, Date Unknown).

Storm Surge

Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Typical storm surge heights range from several feet to more than 25 feet. The exact height of the storm surge and which coastal areas will be flooded depends on many factors: strength, intensity, and speed of the hurricane or storm; the direction it is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape of the shoreline; and the astronomical tide. Storm surge is the most damaging when it occurs along a shallow sloped shoreline, during high tide, in a highly populated, and developed area with little or no natural buffers (for example, barrier islands, coral reefs, and coastal vegetation).

The most common reference to a return period for storm surges has been the elevation of the coastal flood having a 1% chance of being equaled or exceeded in any given year, also known as the 100-year flood. Detailed hydraulic analyses include establishing the relationship of tide levels with wave heights and wave run-up. The storm surge inundation limits for the 1% annual chance coastal flood event are a function of the combined influence of the water surface elevation rise and accompanying wave heights and wave run-up along the coastline.

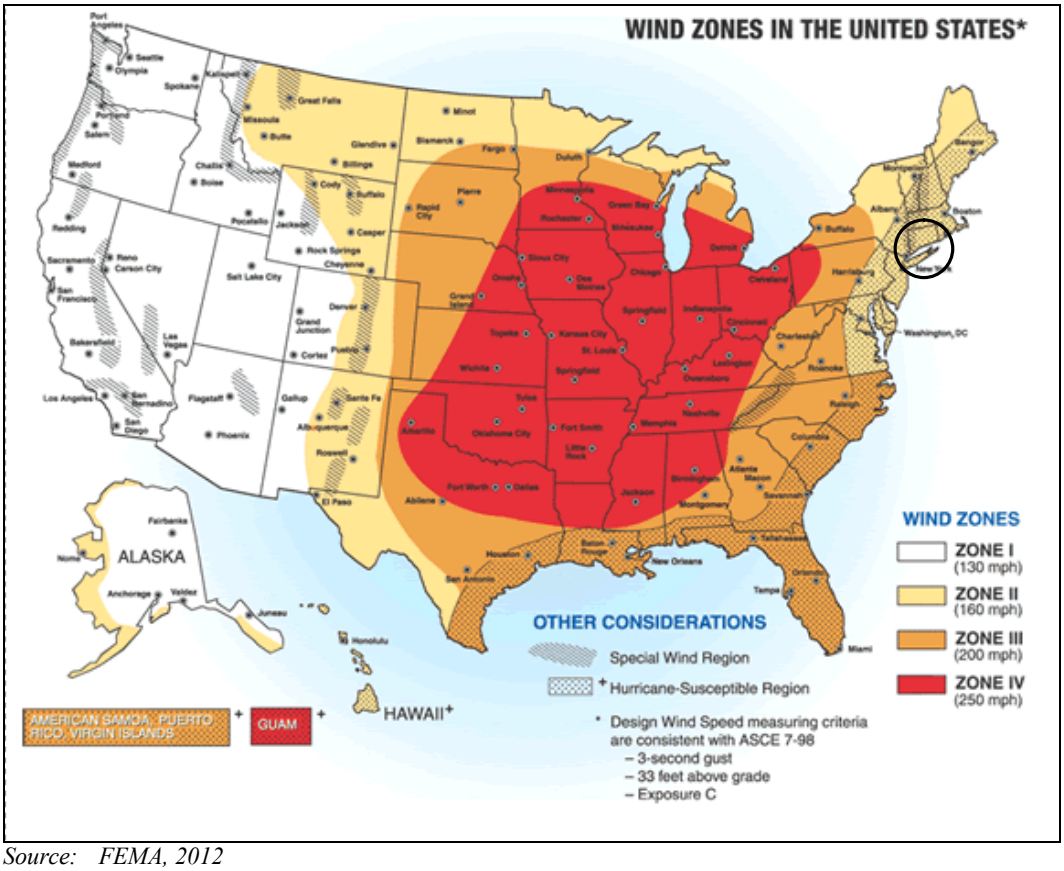
The risk of storm surge elevations higher than 7 feet exists along certain coastal segments of Oregon, Washington, and Alaska; and in every coastal state from Texas to New Jersey. A storm surge associated with storms of longer recurrence intervals may result in more storm surge flooding, higher water levels, larger waves, and an increased likelihood of dune overwash, wave damage, and possible breaching of barrier islands.

Location

Suffolk County is primarily surrounded by coastal waters. Because of this, hurricanes and other tropical cyclones can affect the entire County, particularly impacting communities along the north and south shores of the County.

Figure 5.4.7-11 indicates how the frequency and strength of windstorms impacts the U.S. and the general location of the most wind activity. This is based on 40 years of tornado history and 100 years of hurricane history, collected by FEMA. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes (NVRC, 2006). Suffolk County is located in Wind Zone II with speeds up to 160 miles per hour. Suffolk County is also located within the hurricane-susceptible region (FEMA, 2012). The NYS HMP identifies counties most vulnerable to wind, as determined by a rating score. Counties accumulate points based on the value of each vulnerability indicator, the higher then indication for wind exposure the more points assigned, resulting in a final rating score. Suffolk County was given a rating score of 19 (NYS DHSES, 2011).

Figure 5.4.7-11. Wind Zones in the U.S.



Source: *FEMA, 2012*
Note: *The black circle indicates the approximate location of Suffolk County.*

Table 5.4.7-3. Wind Zones in the U.S.

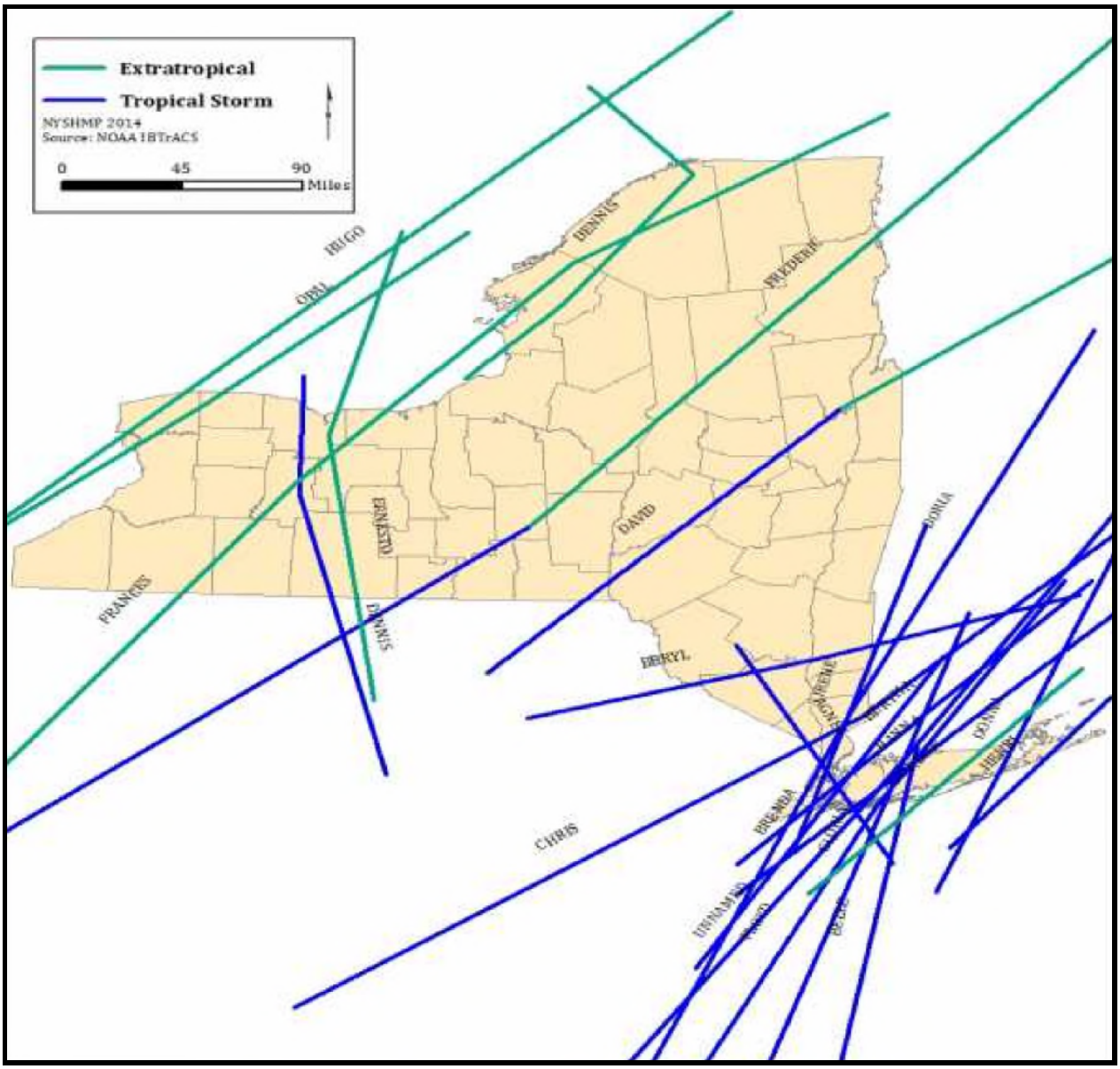
Wind Zones	Areas Affected
Zone I (130 mph)	All of Washington, Oregon, California, Idaho, Utah, and Arizona. Western parts of Montana, Wyoming, Colorado and New Mexico. Most of Alaska,

Wind Zones	Areas Affected
	except the east and south coastlines.
Zone II (160 mph)	Eastern parts of Montana, Wyoming, Colorado, and New Mexico. Most of North Dakota. Northern parts of Minnesota, Wisconsin and Michigan. Western parts of South Dakota, Nebraska and Texas. All New England States. Eastern parts of New York, Pennsylvania, Maryland, and Virginia. Washington, DC.
Zone III (200 mph)	Areas of Minnesota, South Dakota, Nebraska, Colorado, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, New York, Michigan, and Wisconsin. Most or all of Florida, Georgia, South Carolina, North Carolina, Virginia, West Virginia. All of American Samoa, Puerto Rico, and Virgin Islands.
Zone IV (250 mph)	Mid US including all of Iowa, Missouri, Arkansas, Illinois, Indiana, and Ohio and parts of adjoining states of Minnesota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Pennsylvania, Michigan, and Wisconsin. Guam.
Special Wind Region	Isolated areas in the following states: Washington, Oregon, California, Idaho, Utah, Arizona, Montana, Wyoming, Colorado, New Mexico. The borders between Vermont and New Hampshire; between New York, Massachusetts and Connecticut; between Tennessee and North Carolina.
Hurricane Susceptible Region	Southern US coastline from Gulf Coast of Texas eastward to include entire state of Florida. East Coastline from Maine to Florida, including all of Massachusetts, Connecticut, Rhode Island, Delaware, and Washington DC. All of Hawaii, Guam, American Samoa, Puerto Rico and Virgin Islands.

Source: NYS DHSES, 2011

Figure 5.4.7-12 show historical storm tracks that have gone through New York State between 1960 and 2011. The vast majority of these storms have been over the eastern part of the State, specifically in the southeastern corner, with a few passing directly over Suffolk County (NYS DHSES 2013).

Figure 5.4.7-12. Hurricane Tracks in New York State, 1960 to 2011.

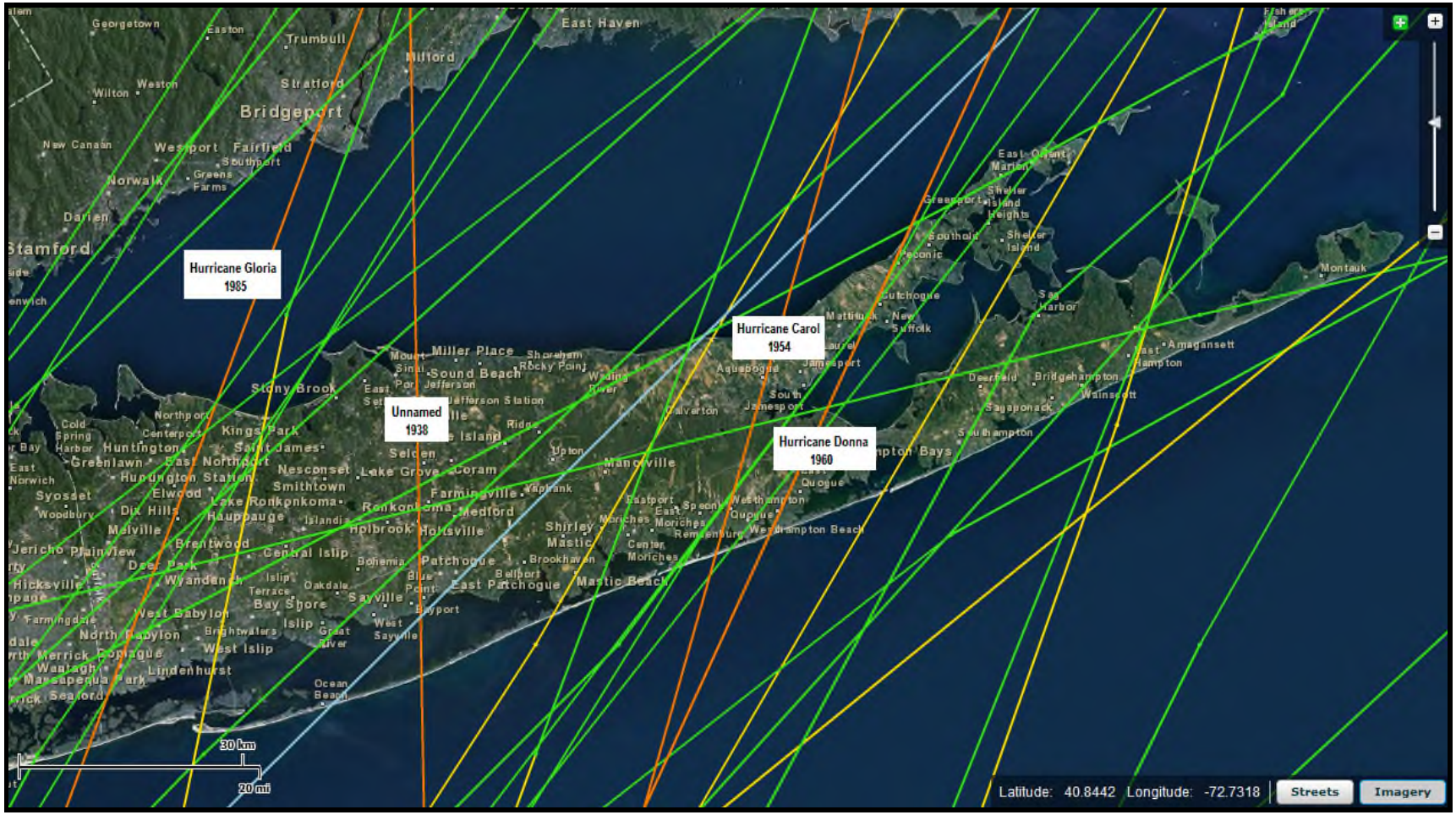


Source: NYS DHSES 2013

Multiple sources have indicated that Suffolk County has been impacted by many hurricanes, tropical storms and tropical depressions. The County has felt the direct and indirect landward effects associated with several hurricanes and tropical storms in recent history. These storms are based on the Historical Hurricane Tracker, which includes storms through 2012.

The Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool tracks tropical cyclones from 1842 to 2012. Figure 5.4.7-13 displays tropical cyclone tracks for Suffolk County; however, the associated names for some of these events are unknown. Between 1842 and 2012, Suffolk County has experienced 33 tropical cyclone events within 50 nautical miles of the county (NOAA, 2013).

Figure 5.4.7-13. Historical North Atlantic Tropical Cyclone Tracks (1842-2012)



Source: NOAA, 2013

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hurricane events throughout New York State and Suffolk County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

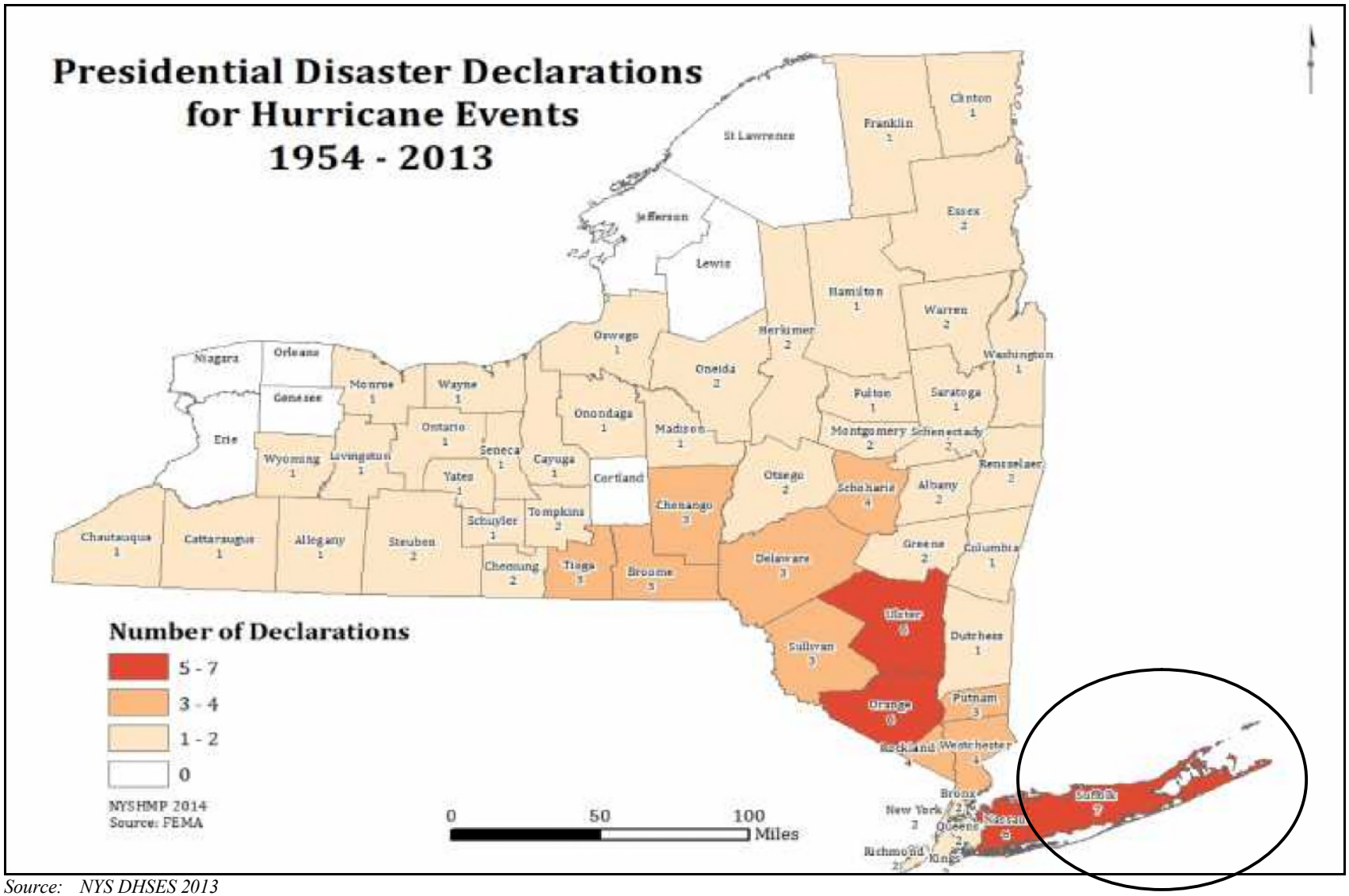
According to NOAA's NCDC storm events database, Suffolk County experienced 2 hurricane or tropical storm events between 1950 and 2013. Total property damages as a result of these events were estimated at $70,500.

The Hazard Research Lab at the University of South Carolina's Spatial Hazard Events and Losses Database for the U.S. (SHELDUS) is a county-level hazard data set for the U.S. for 18 different natural hazard event types (avalanche, coastal, drought, earthquake, flooding, fog, hail, heat, hurricane/tropical storm, landslide, lightning, severe storm/thunderstorm, tornado, tsunami/seiche, volcano, wildfire, wind, and winter weather). Currently, the database includes every loss causing and/or deadly event between 1960 and 1992 and from 1995 onward. Between 1993 and 1995, SHELDUS reflects only events that caused at least one fatality or more than $50,000 in property or crop damages. Therefore, the numbers provided by SHELDUS do not represent all severe storm weather events that occurred in Suffolk County. According to SHELDUS, between 1960 and 2012, nine hurricane/tropical storm events occurred within Suffolk County. The database indicated that hurricane/tropical storm events and losses specifically associated with the County and its municipalities totaled over $7.9 million in property damage and over $6.5 million in crop damage.

Between 1954 and 2013, FEMA declared that New York State experienced 14 hurricane-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane and tropical storm. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Of those events, the NYS HMP and other sources indicate that Suffolk County has been declared as a disaster area as a result of seven hurricane events (FEMA, 2012). Figure 5.4.7-14 shows the FEMA disaster declarations (DR) for hurricanes in New York State, from 1954 to 2013. This figure indicates that Suffolk County was included in nine disaster declarations.

For this 2014 Plan Update, known hurricane and tropical storms events that have impacted Suffolk County between 2008 and 2013 are identified in Table 5.4.7-4. Events identified in the 2007 Plan are included in Appendix H. With hurricane and tropical storm documentation for New York State and Suffolk County being so extensive, not all sources have been identified or researched. Therefore, Table 5.4.7-4 may not include all events that have occurred in the County. Please note Nor'Easter hazard events will be addressed specifically in Section 5.4.9.

Figure 5.4.7-14. Presidential Disaster Declarations for Hurricane Events, 1954 to 2013



Source: NYS DHSES 2013
Note: The black circle indicates the approximate location of Suffolk County. According to the figure, the County has been included in nine FEMA major disaster declarations

Table 5.4.7-4. Hurricane and Tropical Storm Events Between 2008 and 2013

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
September 6-7, 2008	Tropical Storm Hanna	N/A	N/A	Some beach erosion; trees down; no injuries or fatalities; approximately $70,000 in damages	NOAA-NCDC
November 12-14, 2009	Severe Storms and Flooding Associated with Tropical Depression Ida and a Nor'Easter	DR-1869	Yes	Severe storms and coastal flooding caused an estimated $17 M in damages. Severe beach erosion and cuts into the dunes occurred along the Atlantic Ocean facing beaches.	NYS HMP
September 3, 2010	Remnants of Hurricane Earl	N/A	N/A	Rainfall totals in Suffolk County ranged from 0.01 inches in Farmingdale to 2.62 inches in Westhampton Beach.	NWS
August 28, 2011	Tropical Storm Irene	DR-4020 / EM-3328	Yes	As Hurricane Irene moved north along the Atlantic coast, it weakened and made its second landfall as a Tropical Storm near Little Egg Inlet along the southeast New Jersey coast. The storm made its third landfall in New York City on August 28th. This storm brought sustained winds, heavy rain, destructive storm surge and two confirmed tornadoes. Seven deaths resulted from Irene. At least 600,000 people were ordered to evacuate their homes from storm surge and inland flooding. Widespread power outages of up to one week followed the storm. In Suffolk County, the maximum sustained winds measured at 39 knots, with gusts of 53 knots. According to the NWS, peak wind gusts in Suffolk County ranged between 28 mph to 91 mph, with 37 mph wind gusts in the Village of Westhampton Beach and 65 mph in the Hamlet of Bridgehampton. Rainfall totals ranged from 1.07 in the Village of Westhampton Beach (Southampton) to 6.78 inches in Northport. Other rainfall totals for the Town of Southampton include 1.19 inches in the Village of Sag Harbor and 1.36 inches in the Hamlet of Bridgehampton. FEMA issued a disaster declaration for several counties in New York State, including Suffolk County. Suffolk County was approved for IA and PA. FEMA approved $102,884,828.74 in total IA and $459,751,510.20 and total PA grants.	FEMA, NOAA-NCDC, NWS
September 7 -10, 2011	Remnants of Tropical Storm Lee	DR-4031 / EM-3341	No	Rainfall totals from Tropical Storm Lee ranged between 1.17 inches in Lindenhurst to 4.91 inches in Montauck Point in Suffolk County.	FEMA, NOAA-NCDC, NWS

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts	Source(s)
October 29, 2012	Hurricane Sandy	DR-4085 / EM-3351	Yes	Hurricane Sandy was the 19th named tropical cyclone of the 2012 Atlantic hurricane season. The track of Hurricane Sandy resulted in a worse-case scenario for storm surge for coastal regions from New Jersey north to Connecticut, including New York City and Long Island. In Suffolk County, maximum wind gusts ranged between 66 mph (town of East Hampton) to 96 mph (hamlet of Eatons Neck). A high surf advisory was issued prior to the storm for the south shore of Long Island and a coastal flood warning was issued. Storm surge reached several feet along the entire coast of the County, measured at over 6 feet in the village of Lindenhurst and over 5 feet in the hamlet of Montauk. During the event, peak storm tide in the hamlet of Hampton Bays was 6.53 feet on October 30th. Overall, the County, its towns, villages, and hamlets experienced power outages, school and business closings, flooding, fuel shortages, downed utility poles and trees. FEMA issued a disaster declaration for several counties in New York State, including Suffolk County. Suffolk County was approved for IA and PA. FEMA approved $944,478,644.95 in IA for the State and $816,955,000.39 in total PA grants.	FEMA, NWS

Sources: *FEMA, NOAA-NCDC, NWS, SHELDUS*
Note: *Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of inflation.*
DR *Federal Disaster Declaration*
EM *Federal Emergency Declaration*
FEMA *Federal Emergency Management Agency*
HMP *Hazard Mitigation Plan*
IA *Individual Assistance*
K *Thousand ($)*
M *Million ($)*
Mph *Miles Per Hour*
NCDC *National Climate Data Center*
NOAA *National Oceanic Atmospheric Administration*
NYS *New York State*
NWS *National Weather Service*
PA *Public Assistance*
SHELDUS *Spatial Hazard Events and Losses Database for the U.S.*

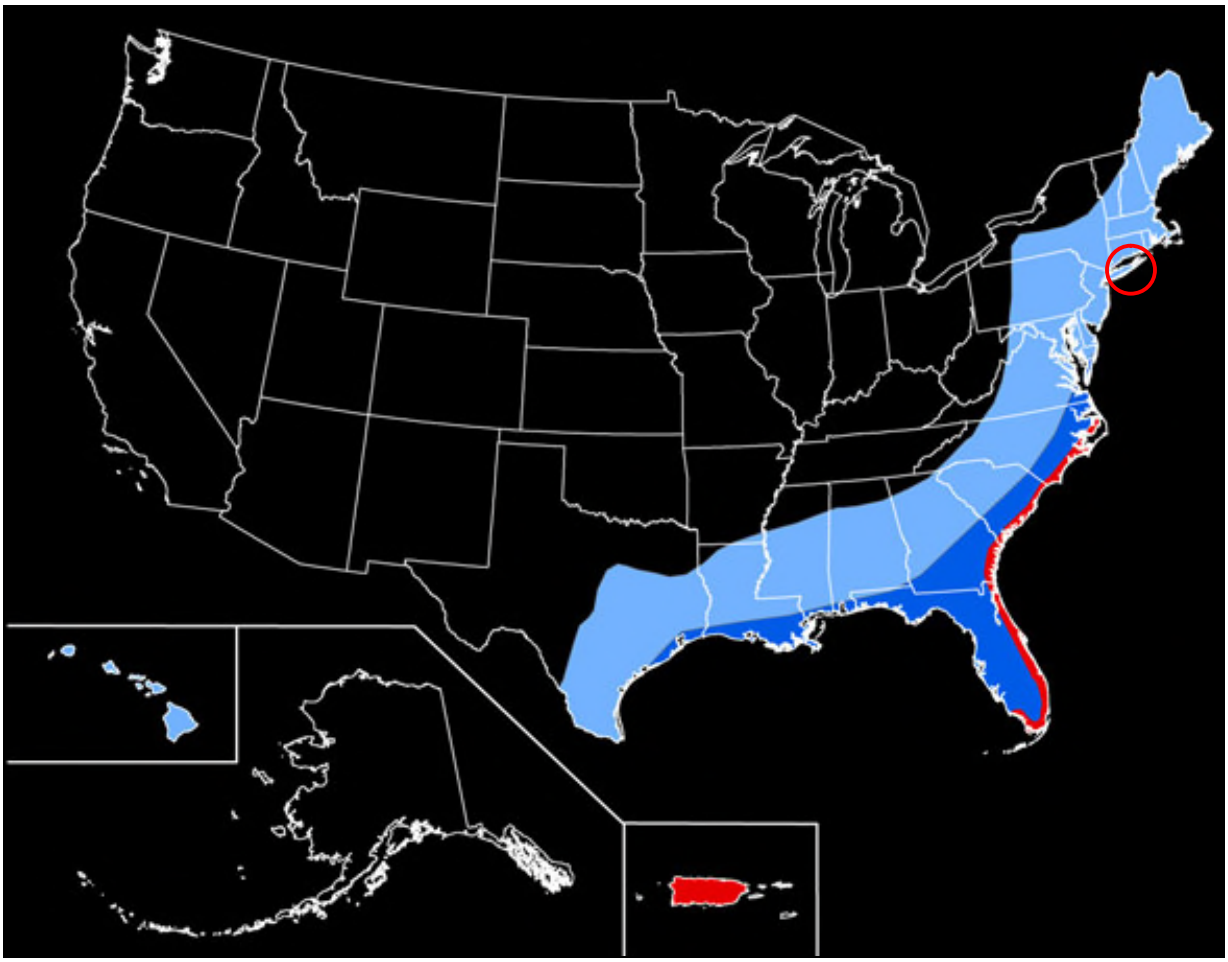
Probability of Future Events

In Section 5.3, the identified hazards of concern for Suffolk County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Planning Committee, the probability of occurrence for hurricanes and tropical storms in the Planning Area is considered 'frequent' (likely to occur more than once every 10 years, as presented in Table 5.3-3).

It is estimated that Suffolk County will continue to experience direct and indirect impacts of hurricanes and tropical storms annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Figure 5.4.7-15 illustrates the number of hurricanes expected to occur during a 100-year period. According to this map, portions of New York State, including Suffolk County, can expect between 20 and 40 hurricanes during a 100-year return period.

Figure 5.4.7-15. Number of Hurricanes for a 100-year Return Period



Source: *USGS, 2005*
Note: *The number of hurricanes expected to occur during a 100-year MRP based on historical data—light blue area, 20 to 40; dark blue area, 40 to 60; red area, more than 60. Map not to scale.*

Climate Change Impacts

Climate change is beginning to affect both people and resources in New York State, and these impacts are projected to continue growing. Impacts related to increasing temperatures and sea level rise are already being felt in the State. ClimAID: the Integrated Assessment for Effective Climate Change in New York State (ClimAID) was undertaken to provide decision-makers with information on the State's vulnerability to climate change and to facilitate the development of adaptation strategies informed by both local experience and scientific knowledge (New York State Energy Research and Development Authority [NYSERDA], 2011).

Each region in New York State, as defined by ClimAID, has attributes that will be affected by climate change. Suffolk County is part of Region 4, New York City and Long Island. Some of the issues in this region, affected by climate change, include: the area contains the highest population density in the State; sea level rise and storm surge increase coastal flooding, erosion, and wetland loss; challenges for water supply and wastewater treatment; increase in heat-related deaths; illnesses related to air quality increase; and higher summer energy demand stresses the energy system (NYSERDA, 2011).

Temperatures and precipitation amounts are expected to increase throughout the State, as well as in Region 4. It is anticipated that by the 2020s, the State's temperature will rise between 1.5 and 3ºF; 3 to 5.5ºF by the 2050s; and 4 to 9ºF by the 2080s. The lower ends of these ranges are for lower greenhouse gas emissions scenarios and the higher ends for higher emission scenarios (NYSERDA, 2011). In Region 4, it is estimated that temperatures will increase by 3ºF to 5ºF by the 2050s and 4ºF to 7.5ºF by the 2080s (baseline of 53ºF).

Annual average precipitation is projected to increase by up to 5% by the 2020s, up to 10% by the 2050s and up to 15% by the 2080s (baseline of 43 inches). This increase will not be distributed evenly over the course of the year. During the winter months is when this additional precipitation will most likely occur, in the form of rain, and with the possibility of slightly reduced precipitation projected for the late summer and early fall. Table 5.4.7-5 displays the projected seasonal precipitation change for the New York City and Long Island ClimAID Region (NYSERDA, 2011).

Table 5.4.7-5. Projected Seasonal Precipitation Change in Region 4, 2050s (% change)

Winter	Spring	Summer	Fall
0 to +15	0 to +10	-5 to +10	-5 to +10

Source: NYSERDA, 2011

Sea level rise projects that do not include significant melting of polar ice sheets suggest one to five inches of rise by the 2020s; five to 12 inches by the 2050s; and eight to 23 inches by the 2080s. Scenarios that include rapid melting of polar ice projects four to 10 inches by the 2020s; 17 to 29 inches by the 2050s; and 37 to 55 inches by the 2080s (NYSERDA, 2011).

The projected increase in precipitation is expected to fall in heavy downpours and less in light rains. The increase in heavy downpours has the potential to affect drinking water; heighten the risk of riverine flooding; flood key rail lines, roadways and transportation hugs; and increase delays and hazards related to extreme weather events (NYSERDA, 2011).

The projected increase in sea level rise has the potential to increase risk of storm surge-related flooding along the coast; expand areas at-risk of coastal flooding; increase vulnerability of energy facilities located in coastal areas; flood transportation and telecommunication facilities; and cause saltwater intrusion into some freshwater supplies near the coasts. High water levels, strong winds, and heavy precipitation

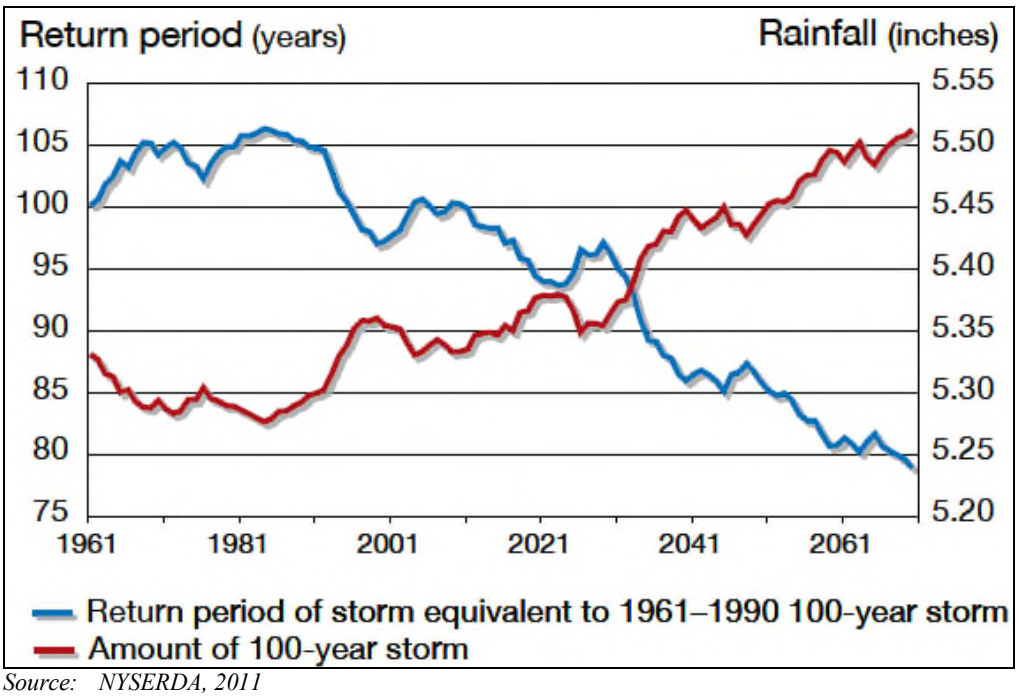
resulting from severe coastal storms already cause billions of dollars in damages and disrupt transportation and utility distribution systems. Sea level rise will lead to more frequent and extensive coastal flooding. Warming ocean waters raise sea level through thermal expansion and have the potential to strengthen the most power storms (NYSERDA, 2011).

Increasing air temperatures intensify the water cycle by increasing evaporation and precipitation. This can cause an increase in rain totals during events with longer dry periods in between those events. These changes can have a variety of effects on the State's water resources (NYSERDA, 2011).

Over the past 50 years, heavy downpours have increased and this trend is projected to continue. This can cause an increase in localized flash flooding in urban areas and hilly regions. Flooding has the potential to increase pollutants in the water supply and inundate wastewater treatment plants and other vulnerable facilities located within floodplains. Less frequent rainfall during the summer months may impact the ability of water supply systems. Increasing water temperatures in rivers and streams will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants (NYSERDA, 2011).

Figure 5.4.7-16 displays the project rainfall and frequency of extreme storms in New York State. The amount of rain fall in a 100-year event is projected to increase, while the number of years between such storms (return period) is projected to decrease. Rainstorms will become more severe and more frequent (NYSERDA, 2011).

Figure 5.4.7-16. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA, 2011

Total precipitation amounts have slightly increased in the Northeast U.S., by approximately 3.3 inches over the last 100 years. There has also been an increase in the number of two-inch rainfall events over a 48-hour period since the 1950s (a 67-percent increase). The number and intensity of extreme precipitation events are increasing in New York State as well. More rain heightens the danger of localized flash flooding, streambank erosion and storm damage (DeGaetano et al [Cornell University], 2010).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the hurricane hazard, the entire Suffolk County Planning Area has been identified as the hazard area for wind. Therefore, all assets in the Planning Area (population, structures, critical facilities and lifelines), as described in the Planning Area section, are vulnerable. In addition, storm surge inundation was evaluated. The following text evaluates and estimates the potential impact of hurricanes on Suffolk County including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability
- Change of vulnerability as compared to that presented in the 2007 Suffolk County Hazard Mitigation Plan
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

The high winds and air speeds of a hurricane often result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals impacted by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. Additionally, hurricanes can cause storm surge related damages along the coast.

Due to Suffolk County's coastal location, the loss associated with hurricanes is primarily associated with hurricane-related rains, storm surge and severe winds. The County has experienced flooding in association with hurricanes and tropical storms in the past. Please refer to Section 5.4.5 (Flood) for more information on the County's vulnerability to this hazard.

The entire inventory of the County is at risk of being damaged or lost due to impacts of hurricanes (severe wind). Certain areas, infrastructure, and types of building are at greater risk than others due to proximity to falling hazards, their manner of construction. Potential losses associated with high winds were calculated for Suffolk County for the 100-year and 500-year MRP hurricane events. In addition, the coastal areas are vulnerable to hurricane storm surge. The impacts on population, existing structures and critical facilities are presented below, following a summary of the data and methodology used.

Data and Methodology

After reviewing historic data, the HAZUS-MH methodology and model were used to analyze the hurricane hazard for Suffolk County. Data used to assess this hazard include data available in the HAZUS-MH 2.1 hurricane model, professional knowledge, information provided by the Steering Committee.

A probabilistic scenario was run for the County for annualized losses and the 100- and 500-year MRPs were examined for the wind/hurricane/tropical storm hazard. These results are shown in Figure 5.4.7-2 through Figure 5.4.7-7, earlier in this section, which show the HAZUS-MH maximum peak gust wind

speeds that can be anticipated in the study area associated with the 100- and 500-year MRP hurricane events. The estimated hurricane track for the 100- and 500-year events is also shown.

HAZUS-MH contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH were used to evaluate potential losses from the 100- and 500-year MRP events (severe wind impacts) at the Census-tract level. Census tracts do not align with municipal boundaries. Therefore, wind-only results are reported only at the Town level. The results reported for each Town are inclusive of the Villages and Tribal Nations located within their municipal boundary.

The "Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide was used to estimate exposure. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the National Weather Service to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves.

All SLOSH analysis for the exposure of population, general building stock, and critical facilities are cumulative analyses. For example, if a facility is located within the category 1 SLOSH zone is also located within the category 2 SLOSH zone. The assumption is that if a facility is affected by a category 1 storm it would also be affected by a category 2 or 3 storm event. For this purposes of this assessment, the population/demographic data presented include only those blocks whose geometric centers fall within the identified hazard areas. Therefore, the assessment is likely to underestimate the population exposed. Impacts to life, health, and safety and structures are discussed below using the methodology described in this paragraph.

Impact on Life, Health and Safety

The impact of a hurricane on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. It is assumed that the entire County population is exposed to the hurricane hazard. Please refer to Section 4 (County Profile) for the total Suffolk County population vulnerable to this hazard.

Suffolk County is densely populated along its coastal shores. A digital version of the U.S. Army Corps of Engineers "New York State Hurricane Evacuation Study – Inundation Maps" (2011) of the hurricane storm surge inundation zones is available for Suffolk County. The inundation maps were based on surge height projections calculated by the National Weather Service's "Sea – Lake Overland Surge from Hurricanes – SLOSH Model." The surge heights were calculated for a number of category 1-4 hurricanes. This data was developed to delineate hazard zones and assess risk from hurricane-related storm surges and to support hurricane evacuation planning. To estimate the population in the hurricane inundation zones, the sum of the population in all Census Blocks with their centroid located in the SLOSH zone was calculated for each participating municipality. Table 5.4.7-6 summarizes the approximate population located in the hurricane inundation zones based on 2010 Census data. This exposure analysis is limited by the Census Block and SLOSH zone configurations. If a Block's centroid is not located within the underlying SLOSH zone it will not produce a result. For example, a portion of the Unkechaug Tribal Nation is located within the Category 1 and Category 2 SLOSH inundation zones, however the Census Block centroid is not located within the SLOSH, even though a portion of the Block is located within the SLOSH zone. This circumstance does not produce an exposure result. Refer to Section 5.4.5 (Flood) for the population located in the coastal flood zones (V-zones).

Table 5.4.7-6. Approximate Population in the Hurricane Inundation Zones

Jurisdiction	Total Population (2010 Census)	Estimated Population in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Amityville (V)	9,523	1,448	4,117	5,712	7,229
Asharoken (V)	654	82	209	209	209
Babylon (T)	164,661	4,023	15,808	23,305	32,696
Babylon (V)	12,166	1,742	5,566	11,290	12,063
Belle Terre (V)	792	0	0	0	0
Bellport (V)	2,084	23	33	103	245
Brightwaters (V)	3,103	0	574	1,068	1,860
Brookhaven (T)	434,886	3,061	10,614	18,131	24,772
Dering Harbor (V)	11	0	0	0	0
East Hampton (T)	18,205	336	893	1,270	1,684
East Hampton (V)	1,083	37	37	67	72
Greenport (V)	2,197	427	752	1,625	2,057
Head of the Harbor (V)	1,472	10	10	10	10
Huntington (T)	190,124	561	1,185	2,186	2,504
Huntington Bay (V)	1,425	49	49	88	221
Islandia (V)	3,335	0	0	0	0
Islip (T)	328,989	5,041	19,671	50,876	73,854
Lake Grove (V)	11,163	0	0	0	0
Lindenhurst (V)	27,253	2,463	7,421	14,693	19,923
Lloyd Harbor (V)	3,660	62	88	120	120
Mastic Beach (V)	14,841	1,051	4,266	6,872	9,597
Nissequoque (V)	1,749	156	242	242	242
North Haven (V)	833	119	197	368	436
Northport (V)	7,401	329	403	471	518
Ocean Beach (V)	79	76	79	79	79
Old Field (V)	918	0	0	194	194
Patchogue (V)	11,798	454	2,981	5,164	7,643
Poquott (V)	953	7	7	7	7
Port Jefferson (V)	7,750	121	269	297	297
Quogue (V)	967	71	156	303	519
Riverhead (T)	33,506	611	1,850	2,818	4,817
Sag Harbor (V)	2,169	216	361	562	735
Sagaponak (V)	313	15	39	43	59
Saltaire (V)	37	37	37	37	37
Shelter Island (T)	2,381	257	358	506	805

Jurisdiction	Total Population (2010 Census)	Estimated Population in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Shoreham (V)	531	0	0	0	0
Smithtown (T)	112773	46	164	246	246
Southampton (T)	49,130	2,258	4,588	7,154	10,762
Southampton (V)	3,109	26	35	77	160
Southold (T)	19,771	2,157	3,048	4,618	6,447
Village of the Branch (V)	1,807	0	0	0	0
West Hampton Dunes (V)	55	34	34	55	55
Westhampton Beach (V)	1,721	149	272	429	572
Shinnecock Tribal Nation	662	104	292	354	449
Unkechaug Tribal Nation	324	0	0	209	209
Suffolk County (TOTAL)	**1,493,350**	**27,659**	**86,705**	**161,858**	**224,404**

Source: U.S. Census 2010 and NYSOEM
Notes: These population estimates do not include the increase in seasonal population along the Suffolk County coast.
** Portions of these villages are located in the SLOSH zones; however, zero population is estimated because no Census Block centroids are located within these zones.*

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. HAZUS-MH estimates there will be 844 displaced households and 183 people that may require temporary shelter due to a 100-year MRP event. For a 500-year MRP event, HAZUS-MH estimates 32,865 households will be displaced and 6,975 people will require short-term sheltering. Refer to Table 5.4.7-7 which summarizes the sheltering estimates for the 100- and 500-year MRP events by jurisdiction.

Table 5.4.7-7. Sheltering Needs for the 100- and 500-year MRP Hurricane Event

Jurisdiction	100-Year MRP		500-Year MRP	
	Displaced Households	People Requiring Short-Term Shelter	Displaced Households	People Requiring Short-Term Shelter
Babylon (T)	8	0	11,890	2,724
Brookhaven (T)	264	56	248	50
East Hampton (T)	123	29	0	0
Huntington (T)	0	0	17,506	3,511
Islip (T)	49	6	2,100	469
Riverhead (T)	53	12	0	0
Shelter Island (T)	9	2	0	0
Smithtown (T)	4	0	1,121	221
Southampton (T)	218	49	0	0
Southold (T)	125	29	0	0
Suffolk County	**853**	**183**	**32,865**	**6,975**

Source: HAZUS-MH v 2.1 (U.S. Census 2000)
Note: Sheltering estimates are based on the default 2000 U.S. Census data in HAZUS-MH. Therefore, these are conservative estimates given the increase in population as indicated by the 2010 U.S. Census data. Shelter estimates are not specifically reported for the Shinnecock and Unkechaug Tribal Nations because the analysis was conducted on the Census tract level and these Nations are included in the Town tracts.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Please refer to Section 4 for the statistics of these populations.

Impact on General Building Stock

After considering the population exposed to the hurricane hazard, the value of general building stock exposed to and damaged by 100- and 500-year MRP hurricane wind event was considered. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a hurricane, followed by a consideration of wind and storm surge impacts (using the methodology described earlier).

Wind Only Hurricane Impacts

The entire study area is considered at risk to the hurricane wind hazard. Please refer to Section 4 (County Profile) which presents the total exposure value for general building stock by occupancy class for Suffolk County.

Expected building damage was evaluated by HAZUS across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 5.4.7-8 summarizes the definition of the damage categories.

Table 5.4.7-8. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very Limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
water.						
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: HAZUS-MH Hurricane Technical Manual

The estimated expected building damage by general occupancy type of various severities for the wind-only analysis is summarized for the entire County HAZUS-MH probabilistic scenarios for the 100- and 500-year events in Table 5.4.7-9.

Table 5.4.7-9. Expected Building Damage by Occupancy Class for 100- and 500-Year Hurricane Events for Suffolk County

Occupancy Class	Severity of Expected Damage	100-year		500-year	
		Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	None	489,405	84.82%	363,014	62.92%
	Minor	72,820	12.62%	116,980	20.28%
	Moderate	12,441	2.16%	54,860	9.51%
	Severe	1,255	0.22%	21,701	3.76%
	Complete Destruction	1,044	0.18%	20,409	3.54%
Commercial Buildings	None	21,213	85.12%	17,291	69.38%
	Minor	2,553	10.24%	2,977	11.94%
	Moderate	972	3.90%	2,751	11.04%
	Severe	182	0.73%	1,864	7.48%
	Complete Destruction	2	0.01%	39	0.16%
Industrial Buildings	None	4,655	91.62%	2,242	44.13%
	Minor	304	5.98%	759	14.95%
	Moderate	93	1.83%	1,000	19.68%
	Severe	27	0.53%	961	18.92%
	Complete Destruction	1	0.03%	118	2.33%

Source: HAZUS-MH 2.1

HAZUS-MH estimates that over 3-percent of the total number of buildings in Suffolk County will be at least moderately damaged in a 100-year wind-only event. There are an estimated 1,075 buildings across all occupancy classes that will be completely destroyed, of which 97-percent are residential buildings. For the 100-year scenario run for the County as a whole, wind speeds equates to a Category 3 hurricane. For the 500-year MRP wind-only event, HAZUS-MH MR3 estimates over 17-percent of the total number of buildings in Suffolk County will be at least moderately damaged. In addition, HAZUS-MH MR3 estimates 20,588 buildings will be completed destroyed. Of the buildings estimated to be completely destroyed, 20,409 are residential or 3.5-percent of the residential building stock. The 500-year MRP wind speeds equate to a Category 4. Residential buildings comprise the majority of the building inventory and are estimated to experience the majority of building damage.

Table 5.4.7-10 summarizes the building value (structure and contents) damage estimated for the 100- and 500-year MRP hurricane wind-only events. Damage estimates are reported for the County's probabilistic HAZUS-MH model scenarios. The data shown indicates total losses associated with wind damage to building structure.

Table 5.4.7-10. Estimated Building Value (Structure and Content) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Jurisdiction	Estimated Total Damages*		Percent of Total Building and Contents RV**		Estimated Residential Damage		Estimated Commercial Damage	
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year
Babylon (T)	$187,592,283	$13,573,962,156	0.2	16.7	$162,072,423	$7,894,438,504	$6,247,318	$1,165,520,914
Brookhaven (T)	$1,725,996,479	$1,596,906,895	0.8	0.7	$1,577,373,061	$1,462,291,741	$63,984,108	$70,950,590
East Hampton (T)	$720,975,178	$5,868,525	3.8	0.0	$660,695,000	$5,715,750	$40,476,460	$111,051
Huntington (T)	$227,878,125	$22,681,256,507	0.2	24.0	$213,307,524	$16,831,608,297	$9,558,138	$3,728,530,736
Islip (T)	$574,924,335	$5,317,985,701	0.5	4.3	$508,658,129	$4,209,001,322	$32,145,673	$568,715,135
Riverhead (T)	$325,488,894	$30,769,153	1.6	0.1	$198,226,996	$26,866,940	$44,688,490	$1,920,457
Shelter Island (T)	$77,030,217	$1,357,451	2.9	0.1	$71,952,500	$1,339,000	$3,506,770	$13,557
Smithtown (T)	$293,791,664	$4,115,858,896	0.4	5.2	$276,336,941	$3,459,363,301	$7,848,988	$223,952,339
Southampton (T)	$1,716,566,622	$62,864,372	3.2	0.1	$1,600,344,598	$61,869,437	$76,800,962	$680,499
Southold (T)	$600,487,753	$13,430,485	3.7	0.1	$495,526,816	$12,714,819	$44,199,216	$359,012
Suffolk County	$6,450,731,550	$47,400,260,141	0.9	6.7	$5,764,493,988	$33,965,209,111	$329,456,124	$5,760,754,290

Source: HAZUS-MH 2.1; Suffolk County Planning Department, 2014; Suffolk County Real Property Tax Service, 2014
**Total Damages is sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government).*
RV Replacement Value

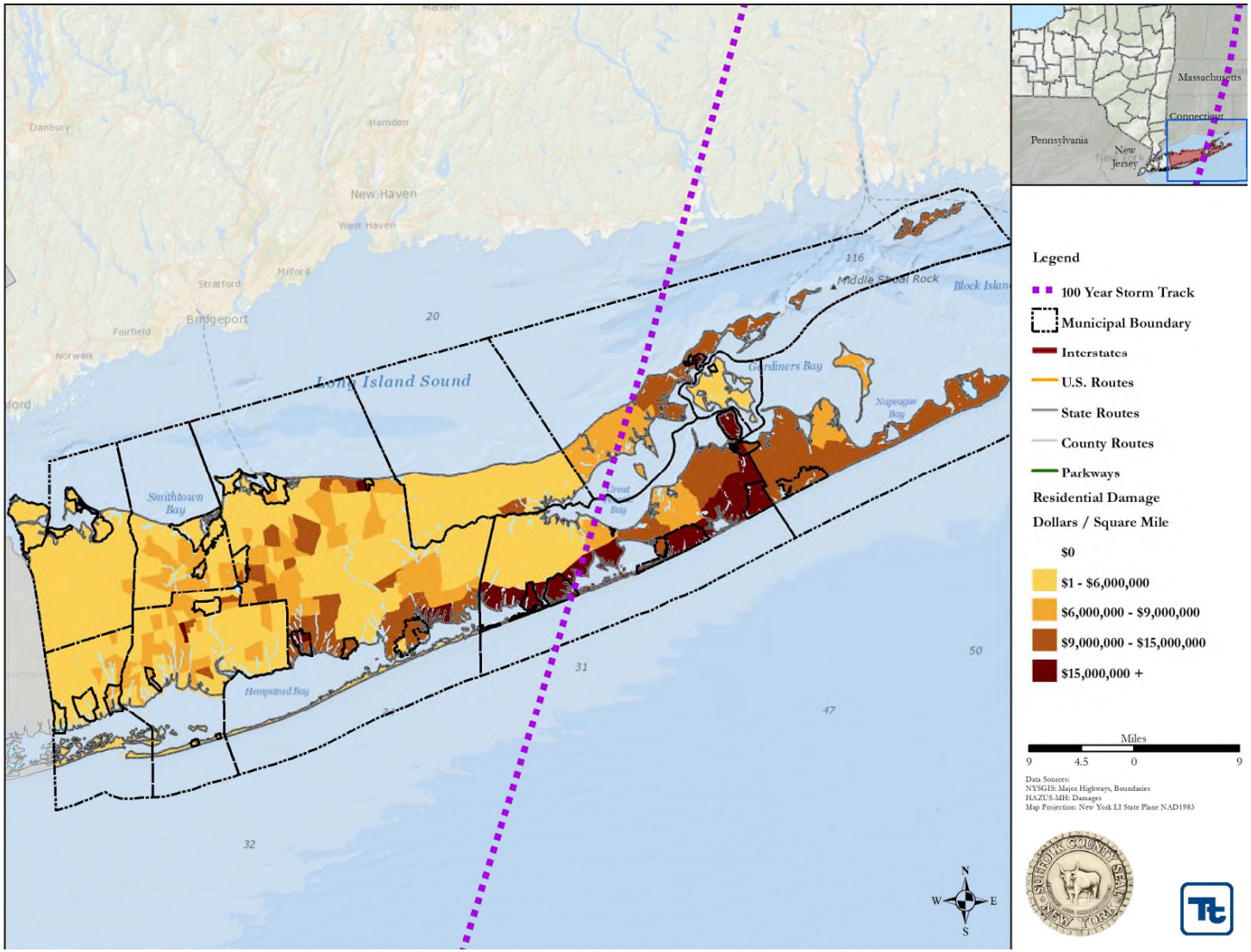
The total damage to buildings (structure and contents) for all occupancy types across the County is estimated to be $6.4 billion for the 100-year MRP wind-only event, and approximately $48 billion for the 500-year MRP wind-only event. The majority of these losses are to the residential building category.

Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. The damage counts include buildings damaged at all severity levels from minor damage to total destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level.

Of the $478 billion in total residential replacement value (structure and contents) for the County (refer to Section 4), an estimated nearly $5.6 billion in residential building damage can be anticipated for the 100-year event and $36 billion in residential building damage can be anticipated for the 500-year event. Residential building damage accounts for approximately 88-percent and 76-percent of total damages for the 100- and 500-year wind-only events, respectively. These results are estimates from the County HAZUS-MH MR3 run. For specific dollar losses estimated for each jurisdiction, please refer to Table 5.4.4-11. This illustrates that losses can be significant, especially to residential structures.

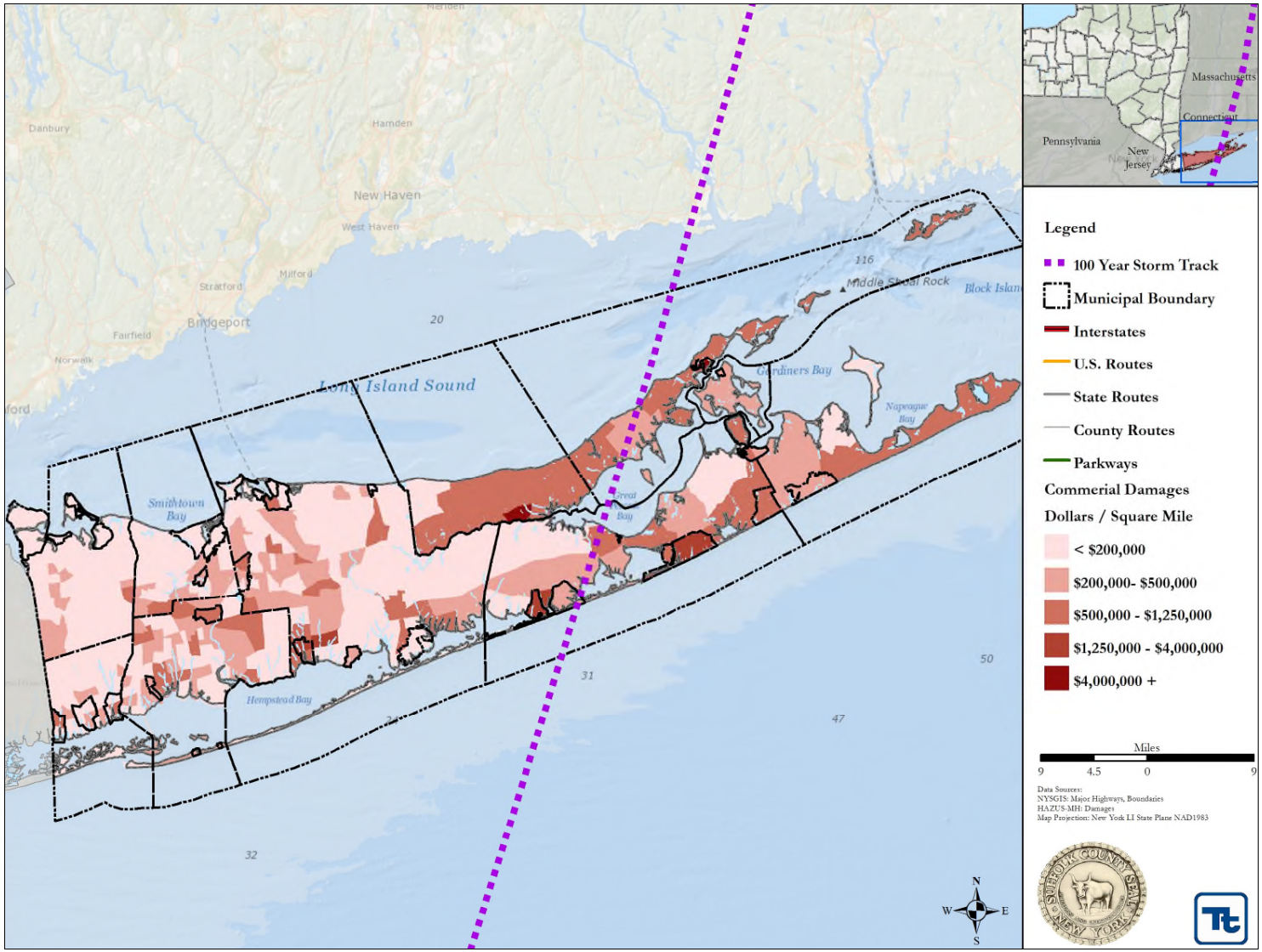
Figure 5.4.7-17 through Figure 5.4.7-20 show the density of damage estimated for residential and commercial structures for the 100-year and 500-year MRP wind events County-wide probabilistic scenarios. As can be seen from the figures, the density of loss to residential buildings is significant for the hurricane-related wind impact.

Figure 5.4.7-17. Density of Losses for Residential Structures (Structure and Content) for the County 100-Year MRP Hurricane (Wind-Only) Event



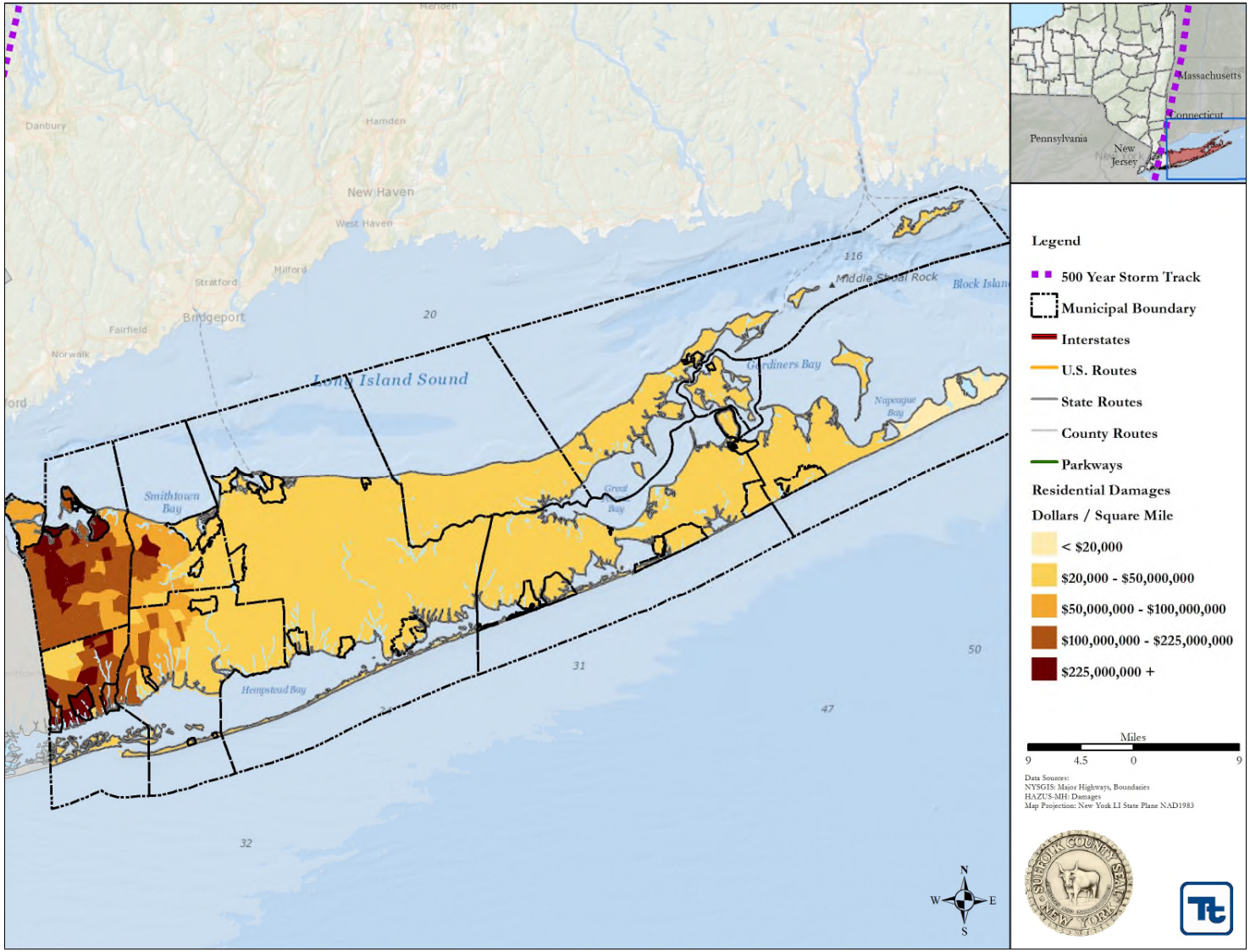
Source: HAZUS-MH 2.1

Figure 5.4.7-18. Density of Losses for Commercial Structures (Structure and Content) for the County 100-Year MRP Hurricane (Wind-Only) Event



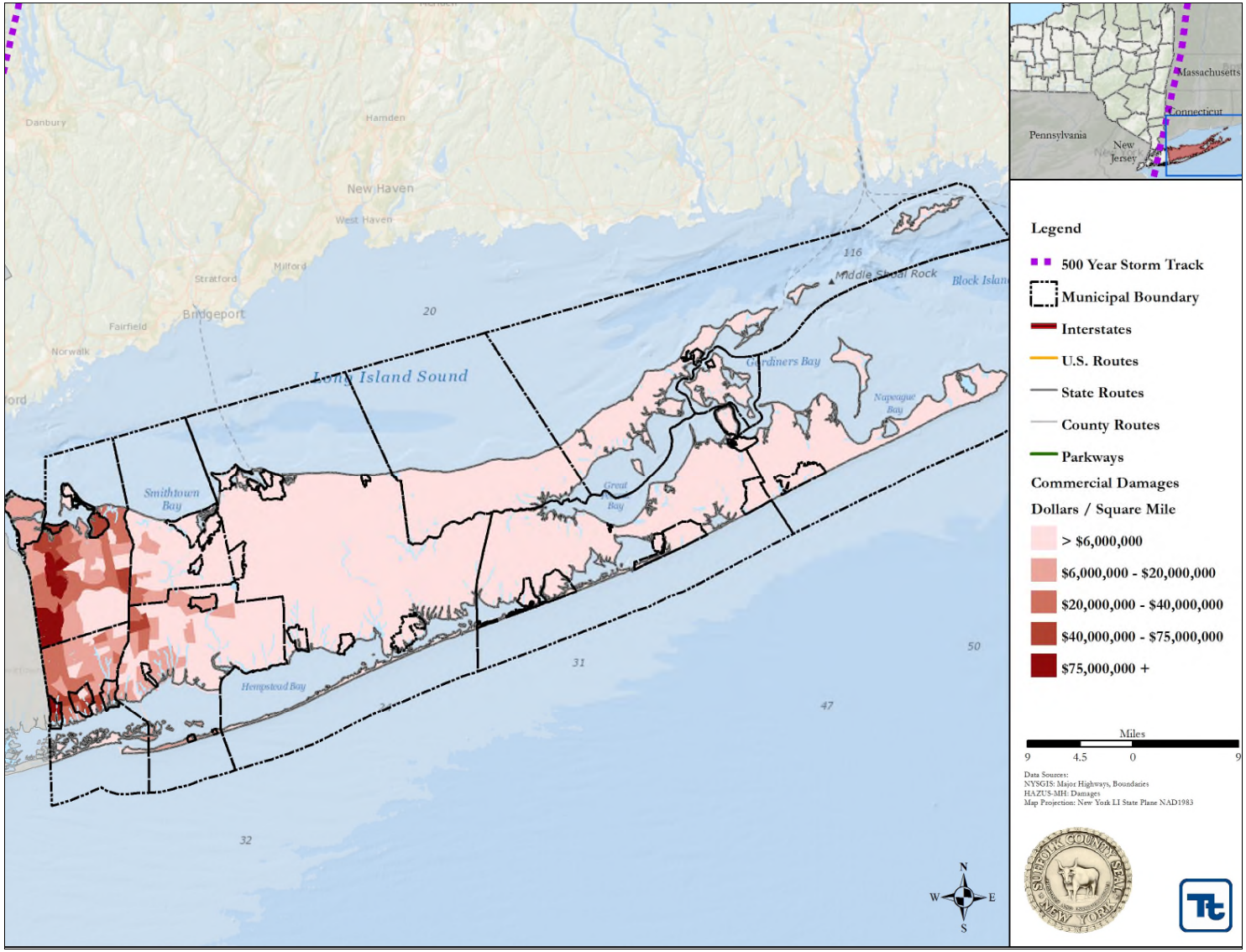
Source: HAZUS-MH 2.1

Figure 5.4.7-19. Density of Losses for Residential Structures (Structure and Content) for the 500-Year MRP Hurricane (Wind-Only) Event



Source: HAZUS-MH 2.1

Figure 5.4.7-20. Density of Losses for Commercial Structures (Structure and Content) for the 500-Year MRP Hurricane (Wind-Only) Event



Source: HAZUS-MH 2.1

Storm Surge Hurricane Impacts

To estimate potential building exposure to storm surge, the SLOSH inundation zones were overlaid with updated building inventory. The structures with their centroid in the inundation zones were used to calculate the estimated exposure. Table 5.4.7-11 and Table 5.4.7-12 summarize the number of buildings and their estimated building replacement cost value exposed to hurricane storm surge by jurisdiction.

Table 5.4.7-11. Number of Buildings in the Hurricane Inundation Zones

Jurisdiction	Total Number of Buildings	Number of Buildings in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Amityville (V)	4,112	656	2,084	2,934	3,627
Asharoken (V)	439	119	305	322	349
Babylon (T)	56,432	1,543	6,518	9,281	12,169
Babylon (V)	5,287	597	2,375	4,690	5,275
Belle Terre (V)	401	1	2	5	7
Bellport (V)	1,684	15	88	242	390
Brightwaters (V)	1,676	3	287	583	950
Brookhaven (T)	165,626	2,170	6,413	10,737	13,924
Dering Harbor (V)	71	1	5	8	12
East Hampton (T)	22,561	435	1,536	2,632	3,659
East Hampton (V)	2,994	3	39	126	247
Greenport (V)	1,363	145	430	926	1,265
Head of the Harbor (V)	836	4	5	11	23
Huntington (T)	76,595	150	474	837	1,133
Huntington Bay (V)	739	32	106	150	192
Islandia (V)	1,195	0	0	0	0
Islip (T)	102,388	2,193	8,526	20,449	29,036
Lake Grove (V)	4,015	0	0	0	0
Lindenhurst (V)	10,823	1,011	3,026	6,014	8,212
Lloyd Harbor (V)	1,807	23	48	86	138
Mastic Beach (V)	7,305	894	3,060	4,497	5,775
Nissequogue (V)	854	23	63	88	115
North Haven (V)	742	13	100	244	357
Northport (V)	3,475	21	65	108	154
Ocean Beach (V)	573	507	555	573	573
Old Field (V)	529	22	62	107	151
Patchogue (V)	4,277	47	569	1,712	2,404
Poquott (V)	480	10	13	21	26
Port Jefferson (V)	2,931	39	98	134	157
Quogue (V)	1,675	182	501	743	960
Riverhead (T)	21,343	485	1,442	2,282	3,652
Sag Harbor (V)	3,011	153	430	646	878

Jurisdiction	Total Number of Buildings	Number of Buildings in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Sagaponack (V)	759	1	32	70	145
Saltaire (V)	443	407	432	440	442
Shelter Island (T)	4,061	94	340	730	1,094
Shoreham (V)	304	0	0	0	0
Smithtown (T)	42,097	26	75	128	195
Southampton (T)	32,382	1,432	4,094	6,223	8,496
Southampton (V)	3,578	60	138	322	509
Southold (T)	21,584	1,182	3,283	5,384	7,707
Village of the Branch (V)	675	0	0	0	0
West Hampton Dunes (V)	285	120	277	285	285
Westhampton Beach (V)	2,265	555	1,105	1,310	1,454
Shinnecock Tribal Nation	618	9	86	245	341
Unkechaug Tribal Nation	146	15	39	78	96
Suffolk County	**617,436**	**15,398**	**49,126**	**86,403**	**116,574**

Source: NYOEM; Suffolk County Planning Department, 2014; Suffolk County Real Property Tax Service, 2014

Table 5.4.7-12. Estimated Building Replacement Cost Value in the Hurricane Inundation Zones

Jurisdiction	Total RCV	Estimated RCV in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Amityville (V)	$4,252,136,181	$347,025,167	$1,261,172,046	$2,072,472,608	$3,283,770,716
Asharoken (V)	$372,107,179	$73,840,063	$244,440,939	$258,556,186	$289,937,148
Babylon (T)	$65,453,076,501	$801,564,864	$4,399,409,423	$6,556,176,678	$9,280,628,648
Babylon (V)	$4,543,925,987	$361,283,603	$2,008,832,059	$4,118,920,562	$4,528,673,112
Belle Terre (V)	$669,659,013	$639,590	$937,929	$2,255,107	$6,734,630
Bellport (V)	$1,916,728,157	$7,875,273	$112,587,773	$293,082,609	$461,808,936
Brightwaters (V)	$1,513,218,570	$1,641,785	$240,353,793	$599,494,198	$949,842,092
Brookhaven (T)	$190,143,257,364	$1,679,838,274	$5,558,038,946	$9,627,425,019	$12,858,404,693
Dering Harbor (V)	$50,907,547	$400,159	$2,838,025	$4,531,436	$6,952,225
East Hampton (T)	$14,753,173,216	$246,921,879	$1,045,826,802	$1,739,885,090	$2,372,615,112
East Hampton (V)	$2,592,657,128	$1,333,368	$23,374,287	$75,686,496	$185,774,294
Greenport (V)	$959,195,848	$145,416,975	$430,627,517	$718,359,124	$894,126,986
Head of the Harbor (V)	$1,460,689,661	$2,861,570	$3,235,338	$10,040,330	$28,155,350
Huntington (T)	$87,620,284,012	$391,950,507	$1,143,430,731	$1,608,654,626	$1,922,323,807
Huntington Bay (V)	$824,147,761	$30,080,007	$122,847,765	$170,110,032	$218,998,695
Islandia (V)	$3,165,387,995	$0	$0	$0	$0
Islip (T)	$116,722,805,765	$1,846,633,565	$8,921,195,015	$21,598,043,527	$29,249,312,953
Lake Grove (V)	$4,981,641,857	$0	$0	$0	$0
Lindenhurst (V)	$7,338,416,625	$528,085,959	$1,969,970,555	$3,956,614,594	$5,894,987,453
Lloyd Harbor (V)	$2,454,429,712	$44,549,946	$72,117,074	$119,358,221	$182,974,269
Mastic Beach (V)	$3,233,984,869	$363,546,604	$1,289,168,259	$1,918,578,930	$2,505,531,957
Nissequogue (V)	$3,556,614,754	$28,021,372	$80,073,320	$162,634,829	$321,346,802
North Haven (V)	$1,038,696,076	$11,163,300	$123,378,976	$311,323,876	$458,150,776
Northport (V)	$3,098,715,281	$18,769,259	$158,412,706	$294,877,636	$400,718,280
Ocean Beach (V)	$506,864,928	$457,852,019	$496,027,651	$506,864,928	$506,864,928
Old Field (V)	$999,833,880	$33,923,133	$115,018,597	$211,495,896	$286,256,630
Patchogue (V)	$5,365,465,598	$44,858,184	$724,382,408	$1,965,087,148	$3,322,688,614

Jurisdiction	Total RCV	Estimated RCV in SLOSH Inundation Zones			
		Cat 1	Cat 2	Cat 3	Cat 4
Poquott (V)	$613,660,785	$2,838,887	$8,083,258	$23,576,824	$31,790,272
Port Jefferson (V)	$4,974,246,594	$116,241,950	$260,205,071	$396,725,738	$433,667,582
Quogue (V)	$2,538,333,603	$233,173,892	$787,110,631	$1,179,513,907	$1,496,412,728
Riverhead (T)	$20,620,083,411	$280,279,453	$912,474,055	$1,439,181,786	$2,363,817,066
Sag Harbor (V)	$2,555,414,041	$176,149,494	$505,629,047	$732,811,616	$924,112,357
Sagaponack (V)	$1,538,825,257	$1,185,600	$39,599,400	$103,925,100	$249,445,884
Saltaire (V)	$577,966,672	$536,500,096	$565,121,906	$573,797,956	$575,672,692
Shelter Island (T)	$2,627,033,680	$101,158,788	$251,401,942	$492,686,788	$717,124,500
Shoreham (V)	$444,350,589	$0	$0	$0	$0
Smithtown (T)	$72,444,940,121	$21,410,154	$85,157,318	$152,210,023	$220,302,281
Southampton (T)	$38,161,684,004	$1,316,923,709	$4,036,138,692	$6,494,096,373	$9,330,071,047
Southampton (V)	$5,883,613,602	$115,312,153	$284,328,260	$668,029,844	$1,109,497,445
Southold (T)	$15,067,456,341	$722,581,960	$2,182,353,789	$3,524,309,198	$5,118,077,235
Village of the Branch (V)	$1,314,993,732	$0	$0	$0	$0
West Hampton Dunes (V)	$309,912,300	$126,960,900	$302,428,200	$309,912,300	$309,912,300
Westhampton Beach (V)	$2,752,056,759	$594,112,963	$1,334,118,949	$1,643,581,039	$1,856,495,319
Shinnecock Tribal Nation	$473,022,431	$4,834,626	$62,877,046	$186,112,761	$262,219,460
Unkechaug Tribal Nation	$76,936,042	$6,606,376	$17,944,581	$39,232,338	$48,474,156
Suffolk County	**$702,562,551,431**	**$11,826,347,426**	**$42,182,670,083**	**$76,860,233,276**	**$105,464,671,427**

Source: NYOEM; Suffolk County Planning Department, 2014; Suffolk County Real Property Tax Service, 2014

Impact on Critical Facilities

HAZUS-MH estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH estimates the loss of use for each facility in number of days. Table 5.4.7-13 and Table 5.4.7-14 list the estimated loss of use in days for each critical facility and the probability of sustaining the damage category as defined by the column heading, for the 100-year and 500-year wind-only events. The damage categories are defined in Table 5.4.7-8, under "Impact on General Building Stock".

Table 5.4.7-13. Estimated Impacts to Critical Facilities by the 100-Year MRP Hurricane Event

	100-Year Event				
		Percent-Probability of Sustaining Damage			
Facility Type	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0	2 -23	0 - 17	0 - 4	0
Medical	0 - 17	0 - 14	1 - 17	1 - 89	0 - 33
Police	0	2 - 24	0 - 21	0 - 7	0
Fire	0	1 - 14	0 - 15	0 - 4	0
Schools	0-92	2-11	0-30	0-32	0

Source: HAZUS-MH 2.1

Table 5.4.7-14. Estimated Impacts to Critical Facilities by the 500-Year MRP Hurricane Event

	500-Year Event				
		Percent-Probability of Sustaining Damage			
Facility Type	Loss of Days	Minor	Moderate	Severe	Complete
EOC	0-1	0 -24	0 - 33	0 - 45	0
Medical	0 - 1	6 - 9	10 - 15	2 - 8	0 - 4
Police	0	0 - 24	0 - 34	0 - 65	0
Fire	0	0 - 15	0 - 33	0 -44	0- 10
Schools	0 - 146	0 - 10	0 - 34	0 - 86	0 - 5

Source: HAZUS-MH 2.1

To estimate potential building exposure to storm surge, the SLOSH inundation zones were used. The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized in **Error! Reference source not found.** by municipality in Table 5.4.7-15 through Table 5.4.7-18.

Table 5.4.7-15. Critical Facilities and Utilities Located in the Category 1 SLOSH Inundation Zones

Municipality	Facility Types																	
	Airport	Bus	CommFac	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Park/rec	POD	Police	PortFac	PotFac	SC Gov Fac	School	Wastewater
Asharoken (V)	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Babylon (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Brookhaven (T)	0	0	2	0	1	0	0	4	1	0	0	0	0	0	8	0	0	0
East Hampton (T)	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0
Greenport (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Huntington (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Islip (T)	0	0	0	0	3	0	1	2	0	0	0	0	0	0	11	0	0	1
Nissequogue (V)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Haven (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Northport (V)	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Ocean Beach (V)	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
Patchogue (V)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Port Jefferson (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Riverhead (T)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	1
Saltaire (V)	1	0	0	0	0	1	0	1	0	0	0	0	1	0	2	0	0	0
Shelter Island (T)	0	0	0	0	0	0	9	0	0	0	0	1	0	1	0	5	0	0
Smithtown (T)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Southampton (T)	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	3	0	0
Southold (T)	2	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0

Municipality	Facility Types																	
	Airport	Bus	CommFac	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Park/rec	POD	Police	PortFac	PotFac	SC Gov Fac	School	Wastewater
West Hampton Dunes (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Suffolk County	**4**	**0**	**5**	**2**	**5**	**1**	**12**	**9**	**2**	**1**	**2**	**3**	**4**	**4**	**24**	**12**	**1**	**7**

Source: NYSOEM; Planning Committee

Table 5.4.7-16. Critical Facilities and Utilities Located in the Category 2 SLOSH Inundation Zones

Municipality	Facility Types																							
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Amityville (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1
Asharoken (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Babylon (T)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	2	0	0	1
Babylon (V)	0	0	0	0	0	3	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Brightwaters (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Brookhaven (T)	0	0	0	0	2	0	0	2	0	0	4	1	0	0	0	0	0	0	10	0	1	0	0	0	0
East Hampton (T)	1	0	0	0	0	0	1	1	0	2	0	1	0	0	0	0	0	0	2	1	1	0	0	0	0
Greenport (V)	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Huntington (T)	0	0	0	1	0	0	1	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	1
Islip (T)	0	0	1	0	0	1	0	3	0	1	2	1	0	0	0	0	1	0	12	0	0	3	2	0	9
Lindenhurst (V)	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Nissequogue (V)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Haven (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Northport (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	1
Ocean Beach (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Patchogue (V)	0	0	0	0	0	0	0	1	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Port Jefferson (V)	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Riverhead (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	4
Sag Harbor (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	2
Saltaire (V)	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Shelter Island (T)	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	1	0	0	6	0	0	0	0

Municipality	Facility Types																								
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Shinnecock Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Smithtown (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Southampton (T)	0	0	0	0	4	2	0	0	0	0	0	1	0	0	0	0	3	0	6	0	5	0	1	0	0
Southold (T)	2	0	0	0	0	1	2	1	0	0	1	0	0	0	0	0	0	1	3	0	1	0	0	0	1
Unkechaug Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
West Hampton Dunes (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Suffolk County	**4**	**0**	**2**	**1**	**8**	**9**	**4**	**9**	**2**	**15**	**18**	**4**	**4**	**2**	**2**	**8**	**8**	**5**	**38**	**2**	**18**	**9**	**3**	**1**	**27**

Source: NYSOEM; Planning Committee

Table 5.4.7-17. Critical Facilities and Utilities Located in the Category 3 SLOSH Inundation Zones

Municipality	Facility Types																							
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Amityville (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1
Asharoken (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
Babylon (T)	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	2	0	0	5	0	0	4	0	0	2
Babylon (V)	0	0	0	0	1	5	0	1	1	0	3	0	1	0	0	0	0	0	4	1	0	5	0	0	0
Brightwaters (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Brookhaven (T)	0	0	0	0	2	0	0	2	0	0	5	1	0	0	0	0	0	0	10	0	1	2	0	0	0
East Hampton (T)	1	0	0	0	0	0	1	1	0	2	0	1	0	0	0	0	0	0	2	1	1	1	0	0	0
Greenport (V)	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Huntington (T)	0	0	0	2	0	0	1	0	0	0	4	0	0	0	0	0	0	0	3	0	0	0	0	0	1
Islip (T)	0	0	2	0	0	2	0	5	1	1	9	2	1	0	0	2	2	0	21	1	0	13	2	0	10
Lindenhurst (V)	0	0	0	0	1	0	0	0	1	0	2	1	1	0	0	1	0	0	0	1	0	4	0	0	0
Mastic Beach (V)	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nissequogue (V)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Haven (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Northport (V)	0	0	0	2	0	0	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	1	0	0	1
Ocean Beach (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Patchogue (V)	0	0	0	0	0	0	0	1	0	2	2	0	2	0	0	0	1	0	1	1	0	2	0	0	2
Port Jefferson (V)	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Quogue (V)	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	2	3	0	0	0
Riverhead (T)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	4	0	0	0	4
Sag Harbor (V)	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	2
Saltaire (V)	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	2	0	0	0	0	0	0

Municipality	Facility Types																								
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Shelter Island (T)	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	1	0	0	6	0	0	0	0
Shinnecock Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0
Smithtown (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Southampton (T)	0	0	0	0	5	2	0	0	0	0	0	1	0	0	0	0	3	0	8	0	7	0	2	0	1
Southold (T)	2	0	0	0	0	1	2	2	1	0	1	0	0	0	0	0	1	1	4	0	1	0	0	0	1
Unkechaug Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
West Hampton Dunes (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Westhampton Beach (V)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1
Suffolk County	**4**	**0**	**3**	**4**	**13**	**12**	**6**	**14**	**5**	**15**	**37**	**6**	**10**	**2**	**2**	**10**	**13**	**5**	**62**	**6**	**23**	**38**	**7**	**13**	**31**

Source: NYSOEM; Planning Committee

Table 5.4.7-18. Critical Facilities and Utilities Located in the Category 4 SLOSH Inundation Zones

Municipality	Facility Types																								
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Non-profit/Rel	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Amityville (V)	0	0	0	0	0	1	0	0	1	0	2	0	1	0	0	0	1	1	0	3	1	0	3	0	0	1
Asharoken (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Babylon (T)	0	0	0	0	0	0	1	1	0	0	3	0	0	0	0	0	2	0	0	12	1	0	7	2	0	2
Babylon (V)	0	1	0	0	1	5	0	1	1	0	3	0	1	0	0	0	0	0	0	4	1	0	5	0	0	0
Brightwaters (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Brookhaven (T)	0	0	0	0	2	0	0	3	0	0	7	1	0	0	0	0	0	0	0	11	0	1	2	0	0	2
East Hampton (T)	1	0	0	0	0	1	1	1	0	2	1	1	0	0	0	0	0	1	0	2	1	1	2	0	0	1
East Hampton (V)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Greenport (V)	0	0	1	0	0	2	1	0	0	0	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
Huntington (T)	0	0	0	3	0	0	1	0	0	0	7	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1
Islip (T)	0	1	2	0	3	2	0	6	1	1	15	2	1	0	0	0	2	2	0	26	3	0	20	2	0	13
Lindenhurst (V)	0	0	0	0	1	1	0	1	1	0	4	1	1	0	0	0	2	0	0	2	1	1	8	0	0	0
Mastic Beach (V)	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nissequogue (V)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Haven (V)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Northport (V)	0	0	0	2	0	0	0	0	0	0	2	0	1	0	0	2	0	0	0	3	0	0	1	0	0	1
Ocean Beach (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Patchogue (V)	0	0	0	0	0	0	0	1	0	2	3	0	4	1	0	0	0	1	0	1	1	1	6	0	0	2
Port Jefferson (V)	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
Quogue (V)	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	2	3	0	0	0
Riverhead (T)	0	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0	1	1	0	0	0	5	1	0	0	7
Sag Harbor (V)	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	2	0	0	0	1	1	0	0	2

Municipality	Facility Types																								
	Airport	Bus	Care Fac	Church	CommFac	DPW/DOT	ElecPow Facility	ElecPow Substation	EOC	Ferry	Fire	Military	Municipal	Non-profit/Rel	Other	Park/rec	POD	Police	PortFac	PotFac	RailFac	SC Gov Fac	School	Senior Facility	Tribal	Wastewater
Saltaire (V)	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Shelter Island (T)	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	2	0	1	0	0	6	0	0	0	0
Shinnecock Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0
Smithtown (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Southampton (T)	0	0	0	0	6	2	0	0	0	0	3	1	0	0	0	0	1	5	0	10	0	11	1	3	0	2
Southampton (V)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Southold (T)	2	1	0	0	0	1	3	3	1	0	3	0	0	0	0	0	1	1	1	9	1	1	1	0	0	1
Unkechaug Tribal Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0
West Hampton Dunes (V)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
Westhampton Beach (V)	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	3	0	1
Grand Total	**4**	**3**	**3**	**5**	**17**	**15**	**7**	**19**	**7**	**15**	**66**	**6**	**14**	**1**	**2**	**2**	**13**	**21**	**5**	**90**	**11**	**31**	**62**	**11**	**14**	**41**

Source: NYSOEM; Planning Committee

Impact on Economy

Hurricanes and tropical storms also impact the economy, including: loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

For the 100-year MRP wind event, HAZUS-MH estimates $321 million in business interruption costs (income loss, relocation costs, rental costs and lost wages). For the 500-year MRP wind only event, HAZUS-MH estimates nearly $3 billion in business interruption losses for the County which includes loss of income, relocation costs, rental costs and lost wages. Further HAZUS-MH estimates $244 million in loss of inventory.

HAZUS-MH 2.1 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. **Error! Reference source not found.** Table 5.4.7-19 estimates the debris produced. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual: '*The Eligible Tree Debris columns provide estimates of the weight and volume of downed trees that would likely be collected and disposed at public expense. As discussed in Chapter 12 of the HAZUS-MH Hurricane Model Technical Manual, the eligible tree debris estimates produced by the Hurricane Model tend to underestimate reported volumes of debris brought to landfills for a number of events that have occurred over the past several years. This indicates that that there may be other sources of vegetative and non-vegetative debris that are not currently being modeled in HAZUS. For landfill estimation purposes, it is recommended that the HAZUS debris volume estimate be treated as an approximate lower bound. Based on actual reported debris volumes, it is recommended that the HAZUS results be multiplied by three to obtain an approximate upper bound estimate. It is also important to note that the Hurricane Model assumes a bulking factor of 10 cubic yards per ton of tree debris. If the debris is chipped prior to transport or disposal, a bulking factor of 4 is recommended. Thus, for chipped debris, the eligible tree debris volume should be multiplied by 0.4'.*

Table 5.4.7-19. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Jurisdiction	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year	100 Year	500 Year
Babylon (T)	10,425	608,390	<100	21,475	10,950	80,319	78,108	569,681
Brookhaven (T)	102,733	96,822	543	547	126,196	97,333	593,239	541,876
East Hampton (T)	42,266	89	1,012	0	76,326	973	250,422	3,404
Huntington (T)	9,241	1,138,613	0	44,595	22,696	316,221	148,804	1,986,039
Islip (T)	27,719	250,197	<100	6,369	41,023	103,997	276,386	726,180
Riverhead (T)	19,321	1,851	287	0	49,289	11,270	98,359	22,192
Shelter Island (T)	4,976	36	<100	0	10,682	0	34,183	0
Smithtown (T)	11,332	165,900	<100	4,057	15,785	73,110	104,675	476,364
Southampton (T)	102,625	1,927	2,272	0	131,724	10,223	420,463	32,741
Southold (T)	36,025	601	909	0	56,440	1,316	183,989	3,916

Suffolk County	**366,663**	**2,264,426**	**5,185**	**77,043**	**541,111**	**694,762**	**2,188,628**	**4,362,392**

Source: HAZUS-MH 2.1

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of hurricanes and the events affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2006).

Change of Vulnerability

Suffolk County and its municipalities continue to be vulnerable to the hurricane hazard. However, there are several differences between the exposure and potential loss estimates between this plan update to the results in the original 2008 HMP. Their differences are due to changes in the HAZUS model and the new and updated population (U.S. Census 2010) and building inventories available and used.

Differences in exposure and potential losses estimated from the 2008 HMP can be attributed to the difference in building stock inventory and methodology used for the risk assessment. For example, the 2008 HMP building inventory used was the default HAZUS-MH general building stock with replacement values based on 2006 RS Means. For this plan update, the potential loss analysis was conducted using a custom County-wide building inventory using 2014 RS Means replacement cost values with a regional factor applied specific to Suffolk County as determined by the Steering Committee. The SLOSH analysis was conducted at the structure-level allowing for more accurate exposure estimates.

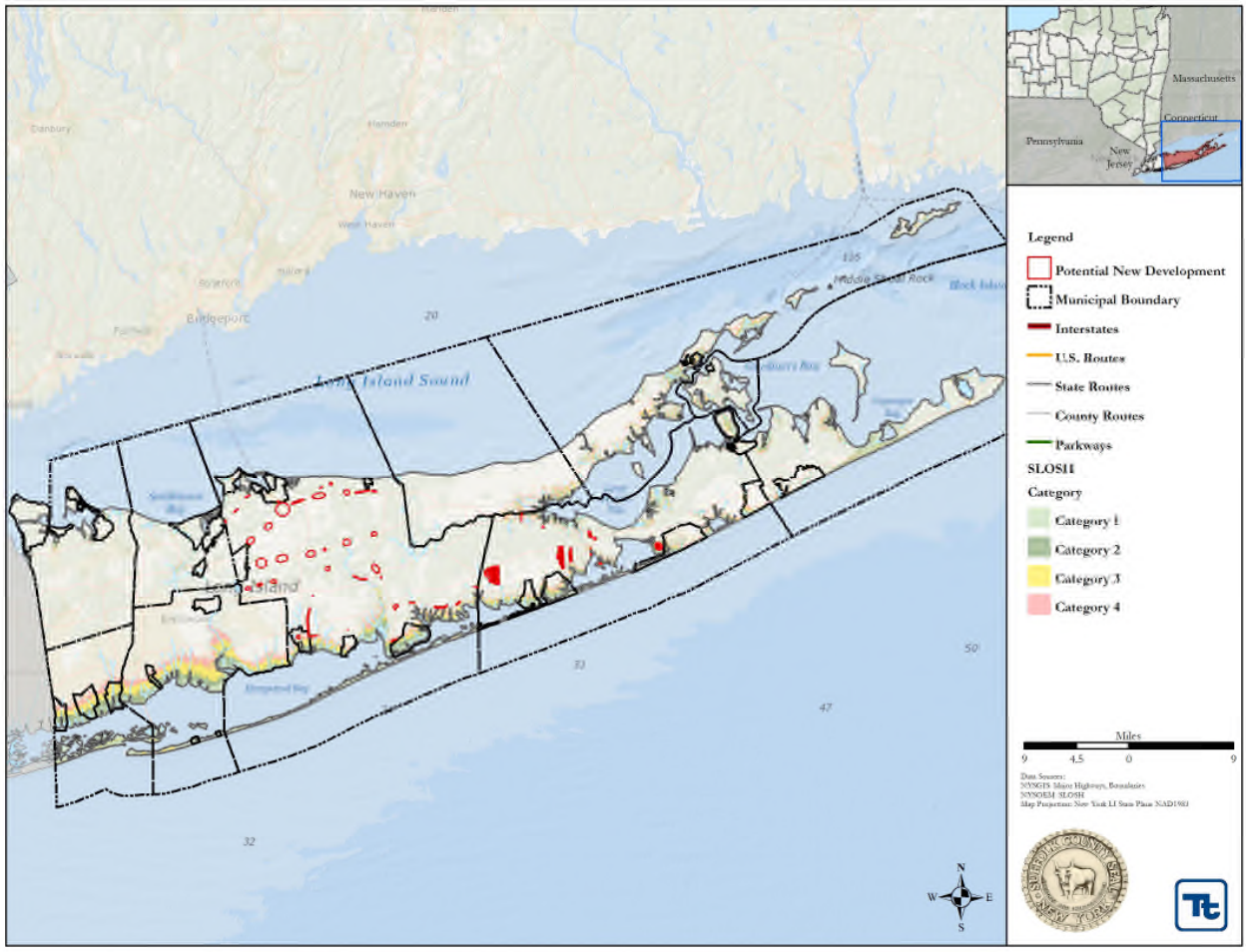
For this plan update, the hurricane was run for the entire County only and reported at the Town level (due to Census tract output in HAZUS). The HAZUS-MH version 2.1 was utilized for this plan update and the hurricane model has been enhanced since MR3.

Overall, this vulnerability assessment using a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for Suffolk County.

Future Growth and Development

As discussed and illustrated in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the hurricane and tropical storm hazard because the entire Planning Area is exposed and vulnerable to the wind and storm surge hazards associated with these events. Areas targeted for potential future growth and development in the next five (5) years have been identified across the County at the jurisdiction level. Refer to the jurisdictional annexes in Volume II of this HMP.

Figure 5.4.7-21. Potential New Development in Suffolk County and SLOSH



Source: NYSOEM

Additional Data and Next Steps

Over time, the County will obtain additional data to support the analysis of this hazard. Data that will support the analysis would include additional detail on past hazard events and impacts, specific building information such as details on protective features (for example, hurricane straps).